ADDITION OF SCRAP TYRE CRUMBS TO PAVEMENT CONCRETE

A Dissertation Submitted in a Partial Fulfillment for the requirement for Award of Degree of

MASTER OF ENGINEERING

In

STRUCTURAL ENGINEERING

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ACKNOWLEDGEMENT

I am extremely grateful to **Dr. A.K. Gupta**, whose invaluable guidance and painstaking supervision made this work possible. His keen attention has been a constant source of inspiration to me. I shall ever remain indebted to him for his keen interest, helpful suggestion, constructive criticism and constant encouragement throughout the project.

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CANDIDATE’S DECLARATION
&
CERTIFICATE

This is to certify that the Major Project Report on topic **“ADDITION OF SCRAP TYRE CRUMBS TO PAVEMENT CONCRETE”** is a bonafide record of work done by me (DEEPAK RAI) for the fulfillment of the degree of “***Master of Engineering (Structures)***” from **DELHI COLLEGE OF ENGINEERING,** Delhi. I have not submitted the matter embodied in the dissertation for the award of any other degree.

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This is to certify that above statement made by **DEEPAK RAI** is correct to the best of my knowledge.

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INTRODUCTION

Scrap tyres are about to become the latest headache for the environment in view of disposal problems. Burning tyres in the open emits significant quantities of hazardous air pollutants including particles, dioxins, carbon monoxide, polyaromatic hydrocarbons and volatile organic compounds. Although a one off tyre fire is temporary but the quantities of contaminants released and their concentration can be significant such as dioxins may bioaccumulate and cause contamination problems over time. The remaining ash residue also contains hazardous contaminants potential creating a contaminated site that requires remediation.

The burning of the waste material such as tyres in the open is typically a prohibited or non-complying activity within air quality plans. As with any fire, tyre dump fire poses a threat to life (or at least of injury) for the general public and more particularly to Fire Fighters. In addition there is a risk of the fire spreading and causing damage to property or natural areas. Burning of tyres result in loss of amenity through visual impacts as a result of the heavy dark smoke and extremely unpleasant odors. There is also the potential for pollutants from tyre fires to enters waterways and contaminate land. The water used to extinguish fire can transport the combustion products (including hydrocarbon and carbon black) from the fire to the water lands or other water.

Smoke from the tyres fire is particularly dark and dense; it has the potential to cause short-term acute health effects if inhaled (eye, nose, and throat irritation, asthma attacks, and respiratory difficulties) and significant odour nuisance. Toxic fumes like Carbon Monoxide and oxides of Nitrogen on account of burning tyres create respiratory problems, dizziness, metabolic disorders and Cancer. Smoke fumes can also reduce visibility on roads leading to unsafe condition.

Suspended particulate matter forms Smog in humid conditions, which reduces visibility resulting in road accidents. The increased air pollution disrupts air traffic. The surveys show that the levels of Carbon Monoxide and suspended particulate matter (SPM) had increased more than 100 folds and 5 folds respectively in the locations where tyres are burnt.

In most of the countries, unwanted tyres are typically disposed off into Landfills or shredded for refuse. Significant quantities are also stockpiled in the hope that an alternative disposal or reuse option will be found.

Many elastomers (including Natural Rubber), both in their virgin form and as recycled material (mainly from Scrap Tyres) have been and are being added to Bitumen or Asphalt to enhance the properties of road surface dressing. There has been interest in Rubber as a paving material for a long time. Rubber has been admixed with bitumen to improve the durability of road since 1930 and there have been many programmes investigated mainly by elastomer producers. The elastomers have been evacuated in the form of lattices and as both vulcanized and unvulcanized powders (fine powder) and Crumbs (large particles). Rubber ranges from the very cheap (various off-grade materials) to the relatively expensive, such as Poly-chloroprene and thermoplastic elastomers. The viscoelastic properties of the bitumen are modified by the addition of elastomeric materials. The advantages are the following:

1. Longer life for the surface dressing.
2. Reduction in cracking and fatting up.
3. Improved resistance to flow or deformation.
4. Improved adhesion and resistance to stripping.
5. Reduction in Aquaplaning (the water drainage capacity may be increased and road noise).
6. The low temperature properties of surface dressing are also improved.
7. In many cases it is possible to achieve a reduction in the pavement thickness.
8. It is possible to lay the material under a wider range of climate conditions.
9. In countries like India, which lack in adequate supply of bitumen, the use of rubber Crumbs from Scrap tyres may be regarded as a means of limiting import.

Test showed that unvulcanized materials (lattices or powders) are about twice as effective as vulcanized virgin materials. Scrap tyres Crumbs showed a very marginal enhancement in the properties of the bitumen in comparison with these materials. Nevertheless, it is at least questionably whether it would be detrimental.

CHAPTER 2

PROPERTIES AND COMPOSITION OF TYRES

A wide range of chemical compounds such as Natural Rubber, SBR (Styrene Butadiene Rubber) and Butadiene Rubber can be found in the tyre rubber of road vehicles. Chemical analysis of tyre material has also revealed that metals such as Zinc, Iron and Calcium can be present in the different concentrations. A large variety of other chemical substances are also added to tyre rubber viz. Vulcanizing agents, Retardants, Pigments, Fillers, Reinforcing agents, Softeners, Antioxidants, Anti-ozonants and desiccants.

Composing by weight in tyre rubber

1. Natural Rubber – 40%
2. SBR – 30%
3. Butadiene Rubber – 20%
4. Butyl and Halogenated Butyl Rubber – 10%

Tyres mainly consist of steel, rubber compounds and textiles (often in the form of cotton). The typical compounds of tyre are as follows:

Tyre composition	**Number of parts containing the material**	**% weight**
Rubber Hydrocarbon	100	51
Carbon Black	50	26
Oil	25	13
Sulphur	2	1
Zinc Oxide	4	2
Other chemicals	15	7

The rubber is made stiffer by the process of Vulcanization. Degree of hardness and stiffness depends upon the quantity of sulphur added. For example, tyre rubber may contain 3-5% sulphur while a battery case rubber contains as much as 30% sulphur.

The following table gives the comparison between properties of raw rubber and Tyre rubber.

S.No.	Property	Raw Rubber	Tyre Rubber
1.	Tensile Strength	200 kg/cm^2	2000 kg/cm^2
2.	Elongation at break (%)	1200	800
3.	Water Absorption	Large	Small
4.	Swelling in Organic Solvents	Infinite	Large
5.	Tackiness	Marked	Light
6.	Useful Temperature Range	10-60^{0}C	-40-100^{0}C
7.	Chemical Resistance	Very poor	Much better
8.	Elasticity	Very high	Depends on degree

The major parts or components of a tyre are the Bead, the Carcass, the Sidewall and the Tread. The composition of the sidewall and tread rubber is given below:

Tread Rubber	Side Wall Rubber
Smoked sheet – 50 parts	Smoked sheet – 50 parts
SBR – 70 parts	SBR – 70 parts
Zinc oxide – 5 parts	Zinc oxide – 5 parts
Stearic acid – 2 parts	Stearic Acid – 2 Parts
ISAF Black – 60 parts	ISAF Black – 45 parts
Softener – 2 parts	Softener – 2 parts
Anti oxidant – 1.5 parts	Anti oxidant – 1.5 parts
Accelerator – 1.0 part	Accelerator – 1.0 part
Sulphur – 2.2 parts	Sulphur – 2.2 parts

The physical properties of the rubber as compared to other polymers are given below:

Material	**Density (10^3 kg/m^3)**	**Thermal Conductivity (J $m^{-1}K^{-1}S^{-1}$)**	**Thermal Expansion ($10^{-6}K^{-1}$)**	**Young's Modulus (GN/m^2)**	**Tensile Strength (MN/m^2)**	**% Elongation**
Tyre Rubber	1.2	0.12	80	1-3	-	-
Polyethylene	0.9	0.34	180	0.2	15-35	100-500
Polystyrene	1.05	0.08	60	3.0	55	3
Nylon	1.15	0.25	100	3.0	80	40-80

Currently 20% of scrap tyres are retreaded, 5% used as boat fenders, silage, clamps etc. 10% crumbed for secondary raw materials, 15% incinerated and 50% land filled, dumped and stockpiled. In 1991 60,000 tones of rubber crumbs was produced in UK, and as much as 20,000 tones are used in sports and play surfaces, brake lining and in road asphalt. Rubberized road can increase road elasticity, temperature range and resistance to oxidation, which can results in fewer ruts, potholes and cracks in pavement surface.

The various uses of Scrap tyres are the following:

1. **Boat and dock fenders.**
2. **Weights on silage sheeting on farms.**
3. **Crash barriers at motor racing circuits.**
4. **Children play surfaces and furniture.**
5. **Protection for young plants and trees.**
6. **Compost heap containers.**
7. **Structural support for earth walls.**
8. **Road surfaces.**

CHAPTER- 3

Experimental Investigation

3.1 Proposed Experimental Work

In this experimental work, the possibility of using Scrap Tyre Crumbs in concrete for pavements is investigated.

Tyre Crumbs of three different sizes will be used to replace 5% of Fine Aggregate in concrete. The compressive strength of 150 mm size Cubes at 28 day will be investigated. The Crumb size giving the highest strength would be chosen.

After fixing the size of the Crumbs, the next step is to find out what percentage of Crumbs gives the higher strength. For that, different percentages of Fine Aggregate viz. 5%, 10%, 15% and 20% will be replaced by scrap tyre Crumbs. Compressive strength and Modulus of Elasticity (Both Static and Dynamic) of the concrete with different percentages of Crumbs will be studied by casting cubes of size 150mm and cylinders of 150mm diameter and 300 mm length.

In order to modify the workability properties of concrete, CEMWET SP 3000 super plasticizer admixture has been used with 5% and 10% of Crumbs. Concrete Cube, Cylinder and Beam specimens have been cast for calculating compressive strength, Modulus of Elasticity and Flexural strength of the modified concrete.

3.2 Materials Used in the Experimental Work

The following materials were used in the experimental work

1. ACC Cement (OPC) (43 Grade) having Specific Gravity of 3.05.
2. Shriram Cement (OPC) (53 Grade) having Specific Gravity of 3.10.
3. Fine aggregate conforming to grading zone II and having Specific Gravity of 2.45.
4. Coarse Aggregate of 20mm size having Specific Gravity of 2.69.
5. Coarse Aggregate of 10mm size having Specific Gravity of 2.70.
6. Scrap tyres Crumbs having Specific Gravity of 0.97.
7. CEMWET SP 3000 admixture, having following properties.

The basic components of CEMWET SP3000 are Synthetic polymers with high molecular weight Naphthalene Formaldehyde Condensates that allows mixing water to be reduced considerably. It is a Chloride free product having prestigious mark of IS: 9103-99. Its typical properties are:

Colour : Brown free flowing liquid.

Specific Gravity: 1.22 – 0.020

Chloride content: NIL to BS: 5075 to IS: 456-1978

Nitrate Content: NIL

Freezing Point: 0^0C can be reconstituted if stirred after thawing.

Air entrained: Maximum 1.5%

Primary uses are:

- Production of plastic self compacting concrete
- Ready Mixed Concrete
- Low Water Cement ratio concrete.

3.3 Experimental Setup

The following instruments were used in the experimental work

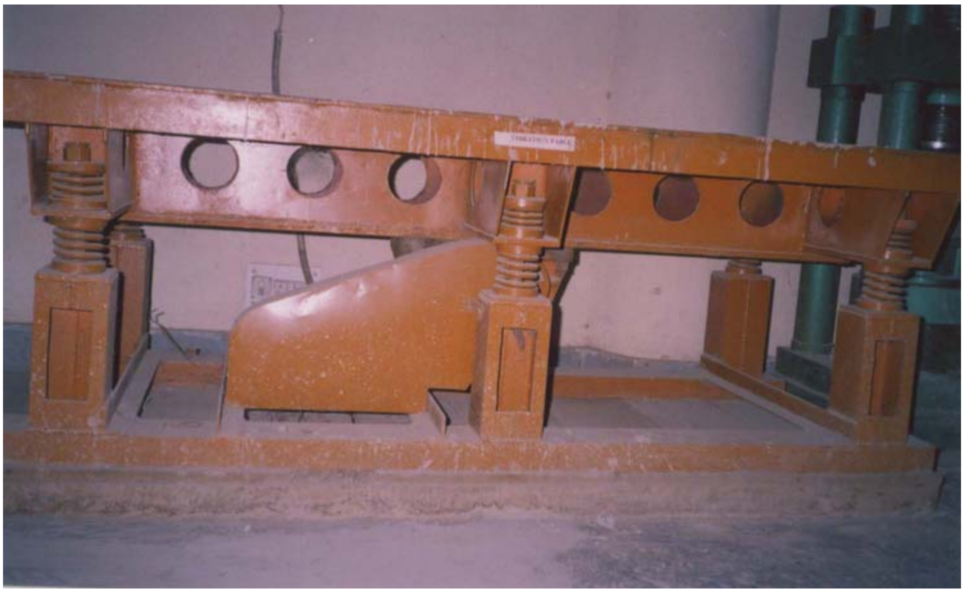
1. Ultrasonic Instrument (As per IS-13311:1992)

The Ultrasonic instrument is used for the non-destructive testing of the concrete. The other data of the Instrument used in experiment work is given below:

(a) Display unit with non-volatile memory for up to 250 measured values, 128x128 graphic LCD.
(b) RS 232 C interface.
(c) Integrated software for transmission of the measured values to PC.
(d) Measuring range: Approx.15 to 6550 μs.
(e) Resolution : 0.1 μs
(f) Voltage pulse : 1KV
(g) Pulse rate : 3/2
(h) Impedance at input : 1 MΩ
(i) Temperature range : -10^0 to $+ 60^0$C
(j) Battery operation with six LR 6 batteries, 1.5 V for 30 hour.
(k) Transducer 54 KHz.
(l) Cable BNC, L = 1.5 m
(m) Calibration rod.
(n) Coupling paste.

2. Vibrating Table

In this type of vibrator, the vibrator is clamped to the table or table is mounted on springs, which are vibrated, transferring the vibrations to the table. They are commonly used for vibrating concrete cubes. This is adopted mostly in the laboratories and in making small but precise prefabricated R.C.C. members.



3. Water Bath

This is used to find out the compressive strength of accelerated cured concrete test specimen. It has temperature control unit by which we can set the required temperature at which concrete specimen are cured.

4. Universal Testing Machine (UTM)

This is used to find out the strength of concrete specimen in compression.

CHAPTER- 4

MIX DESIGN

(As per IS: 10262-1982)

1. Design Stipulations

(a) Characteristic compressive strength required at 28 days = 20 N/mm^2

(b) Maximum size of aggregate = 20mm

(c) Degree of Workability = 0.70 C.F.

(d) Degree of Quality Control = Good

(e) Type of exposure = Mild

2. Test Data for Materials

(a) Specific gravity of Cement = 3.05

(b) Compressive Strength of Cement at 7 Days = Satisfying IS: 269-1989

(c) Specific Gravity of Coarse aggregate = 2.80

(d) Specific Gravity of fine aggregate = 2.44

(e) Water absorption of coarse aggregate = 0.50%

(f) Water absorption of fine aggregate = 1.0%

Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Percentage Weight Retained	Percentage Weight Passing	Remarks
10mm	0	0	0	100	**Conforming to Grading Zone-II of Table-4 IS : 383-1970**
4.75mm	12	12	1.2	98.8	
2.36mm	11	23	2.3	97.7	
1.18mm	70	93	10.0	90.0	
600µ	353	446	44.6	55.4	
300µ	440	886	88.6	11.4	
150µ	91	977	97.7	2.3	
75µ	17	994	99.4	0.6	
Pan	3	1000	100	0	

(i) Target Mean Strength

$f_t = f_{ck} + ks$

$= 20 + (1.65x4) = 26.6\ N/mm^2$

(ii) Selection of Water-Cement Ratio

From Figure 46 of SP: 23-1982, the W/C ratio required for the target mean strength of 26.6 N/mm^2 is 0.48. This is lower than the maximum value of 0.5 prescribed for the Moderate exposure (Refer table 5 of IS: 456-2000). Adopt W/C ratio of 0.48.

So,

Effective W/C ratio = 0.48

(iii) Selection of Water and Sand Content

From Table 42 of SP : 23-1982, for 20 mm maximum size aggregate, sand conforming to grading Zone II, Water content per Cubic meter of concrete is 186 kg/m^3 and sand content as percentage of total aggregate by absolute value is 35%.

For change in value in W/C ratio, compacting factor for sand belonging to Zone II, the following adjustment is required as per Table 44 of SP: 23-1982.

Changed Condition	**Adjustment required in**	
	Water Content	**Sand in Total Aggregate**
For sand conforming to Zone II of table 4 of the IS:383-1970	0.0	0.0
For decrease of C.F. (0.80-0.70)= 0.10	-3.0	0.0
Decrease of W/C ratio (0.60-0.48) = 0.12	0.0	-2.4
Total	-3.0	-2.4

Therefore,

Required Sand content as percentage of total aggregate = 35–2.4=32.6%

Required Water content = 186 – 5.58 = 180.42 kg/m^3

5. Determination of Cement Content

W/C ratio = 0.48

Water = 180.42 kg

So

Cement content = 180.42/0.48 = 375.87 kg/m^3

6. Determination of Coarse aggregate and Fine aggregate content

From Table 41 of SP: 23-1982, for maximum size of aggregate of 20mm, the amount of entrapped air in the wet concrete is 2%, then by equations

$$V = (W + C/S_C + I/P \times f_a/s_{fa}) \times 1/1000$$

0.98 = (180.42 + 375.87/3.04 + 1/0.326 x f_a/2.44) x 1/1000

980 = (303.7 + f_a/0.795)

f_a = 537.5 kg/m^3

Also,

$$V = (W + C/S_C + 1/1\text{-}p \times C_a/S_{ca}) \times 1/1000$$

980 = (303.7/C_a/1.89)

C_a = 1278.2 kg/m_3

Where

C = Cement content per cubic meter of concrete.
S_C = Specific Gravity of Cement
F_a = Content of Fine aggregate per cubic meter of Concrete
S_{fa} = Specific gravity of Fine aggregate
C_a = Content of Coarse aggregate per cubic meter of concrete
S_{ca} = Specific gravity of Coarse aggregate.

Final Mix Proportion is

Water	Cement	Fine Aggregate	Coarse Aggregate
180.42	375.87	537.5	1278.2
0.480	1.0	1.430	3.400

CHAPTER -6

CHOICE OF SCRAP TYRE CRUMBS CONTENT IN CONCRETE

6.1 Effect of percentage of Crumbs on the 28 Days Compressive Strength of Concrete.

6.2 Effect of percentage of Crumbs on the 7 Days Compressive Strength of Concrete.

6.3 Effect of percentage of Crumbs on the 24 Hours Compressive Strength of Concrete.

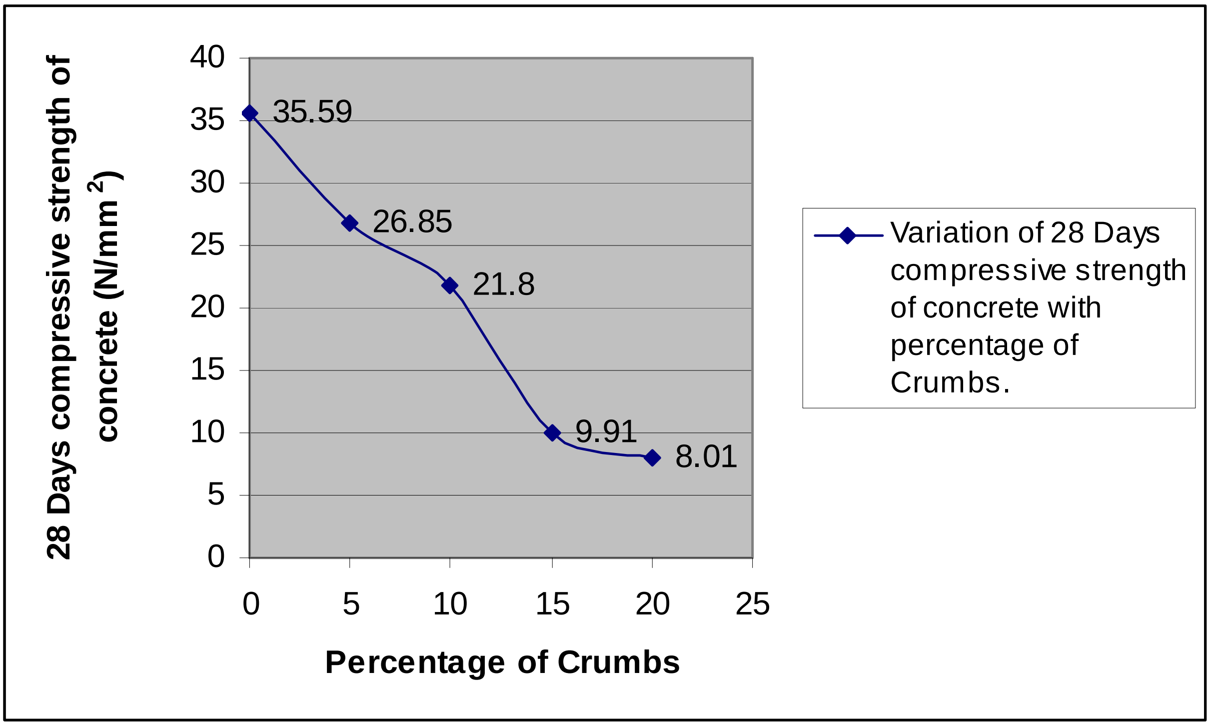
6.4 Effect of percentage of Crumbs on the Dynamic Modulus of Elasticity of Concrete.

Calculation for modified mix proportion with crumbs is presented in Appendix A2.

6.1 Effect of Percentage of Crumbs on the 28 Days Compressive Strength of Concrete

S. No.	Specimen	28 Days Compressive Strength of Concrete (N/mm^2)	Average 28 Days Compressive Strength of Concrete (N/mm^2)
CONTROL MIX			
1.	Cube	34.23	**35.59**
	Cube	35.31	
	Cube	36.84	
	Cube	35.97	
CONCRETE WITH 5% CRUMBS			
2.	Cube	27.69	**26.85**
	Cube	25.60	
	Cube	27.27	
	Cube	26.82	
CONCRETE WITH 10% CRUMBS			
3.	Cube	21.37	**21.80**
	Cube	22.01	
	Cube	22.24	
	Cube	21.58	
CONCRETE WITH 15% CRUMBS			
4.	Cube	9.59	**9.91**
	Cube	10.02	
	Cube	9.81	
	Cube	10.25	
CONCRETE WITH 20%CRUMBS			
5.	Cube	7.63	**8.01**
	Cube	8.07	
	Cube	8.28	
	Cube	8.07	

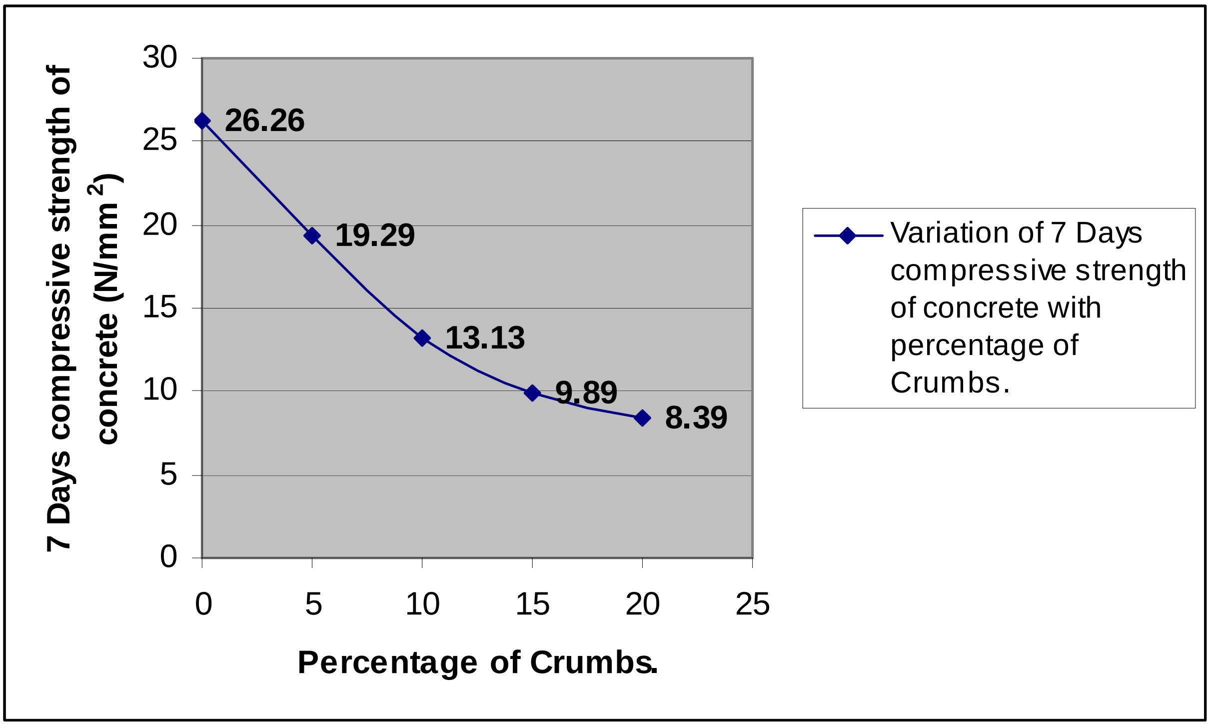
Effect of percentage of Crumbs on the 28 Days Compressive strength of concrete



6.2 Effect of Percentage of Crumbs on the 7 Days Compressive Strength of Concrete

S. No.	Specimen	7Days Compressive Strength of Concrete (N/mm^2)	Average 7DaysCompressive Strength of Concrete (N/mm^2)
CONTROL MIX			
1.	Cube	27.0	**26.26**
	Cube	25.28	
	Cube	25.94	
	Cube	26.82	
CONCRETE WITH 5% CRUMBS			
2.	Cube	17.66	**19.29**
	Cube	19.84	
	Cube	17.44	
	Cube	18.75	
CONCRETE WITH 10% CRUMBS			
3.	Cube	12.21	**13.13**
	Cube	12.86	
	Cube	13.29	
	Cube	14.17	
CONCRETE WITH 15% CRUMBS			
4.	Cube	8.94	**9.89**
	Cube	10.47	
	Cube	9.38	
	Cube	9.81	
CONCRETE WITH 20%CRUMBS			
5.	Cube	8.07	**8.39**
	Cube	8.07	
	Cube	8.51	
	Cube	8.28	

Effect of percentage of Crumbs on the 7 Days Compressive strength of concrete



A comparative study of compressive strength at 28 days and 7 days shows that:

a) **For 0%, 5% and 10% crumbs, the 28 days strength is much higher than the 7 day strength.**

b) **For 15% and 20% crumbs, the 28 days strength is same as 7 days strength.**

This shows that the use of 15% or more crumbs is not going to give good results.

6.3 Compressive Strength By Accelerated Curing By Warm Water Method (IS : 9013-1978)

In this method small cubes of 7.05 cm side are prepared using coarse aggregate of 10mm size only. After the specimens have been made, they are left to stand undisturbed in their moulds in a place free from vibration at a temperature of 27 ± 2^0C for at least one hour prior to immersion in the curing tank. The time between the addition of water to the ingredients and immersion of the specimen in the curing tank is maintained at least 1½ hours but shall not exceed 3½ hours.

The specimens in their moulds are gently lowered into the curing tank and remain totally immersed at 55 ± 2^0C for a period of not less than 19 hours 50 minutes. The specimen are then removed from the water, removed from the mould and immersed in the cooling tank at 27 ± 2^0C before the completion of 20 hours 10 minutes from the start of immersion in the curing tank. They remain in the cooling tank for a period of not less than one hour.

Let,

R_a = Accelerated strength of specimen in N/mm^2 at 24 hours.

R_{28} = Strength of specimen after 28 days in N/mm^2.

Then,

From **IS: 9013-1978** the 28 days compressive strength of specimen can be calculated from accelerated strength by the regression equation.

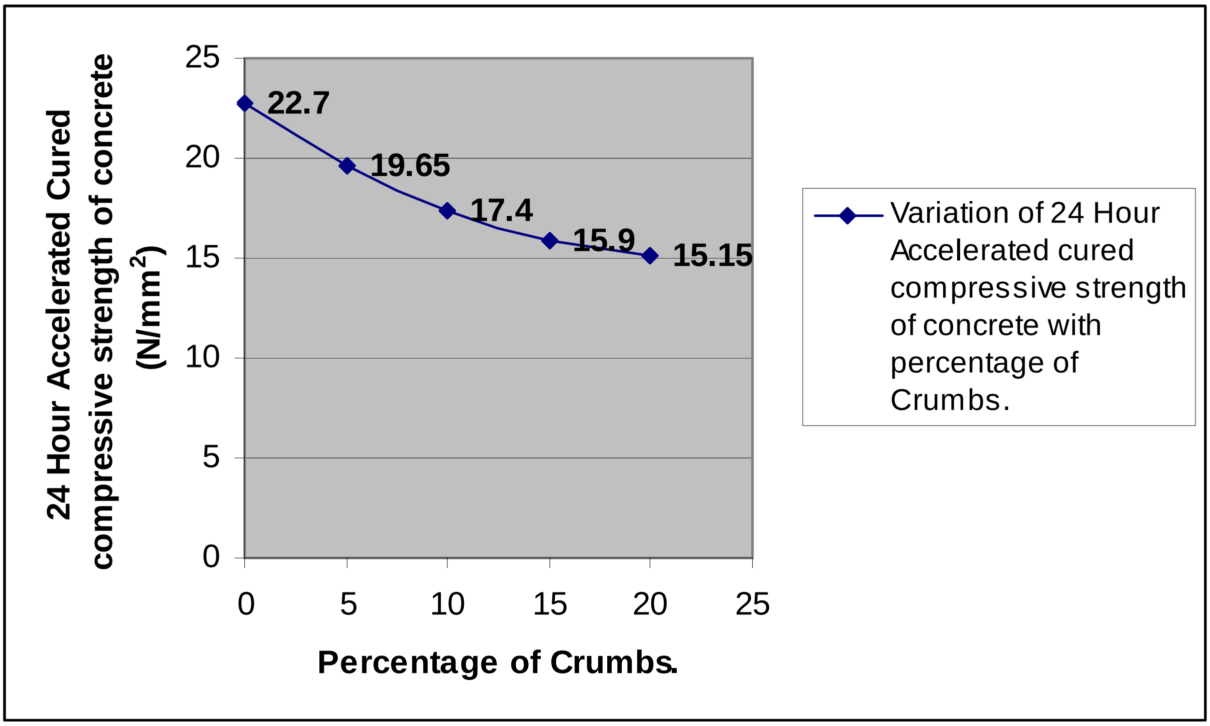
$$\mathbf{R_{28} = 12.65 + R_a}$$

Calculation of modified mix design are presented in Appendix A3

Effect of Percentage of Crumbs on the 24 Hour Accelerated cured compressive strength of concrete

S. No.	Specimen	Accelerated Curing Strength (R_e) (N/mm^2)	Estimated 28 Days Compressive Strength (R_{28}) (N/mm^2)	Average 28 Days estimated Compressive Strength (N/mm^2)
CONTROL MIX				
1.	Cube	11.01	23.66	**22.70**
	Cube	10.01	22.66	
	Cube	10.21	22.86	
	Cube	9.00	21.65	
CONCRETE WITH 5% CRUMBS				
2.	Cube	8.00	20.65	**19.65**
	Cube	7.00	19.65	
	Cube	6.00	18.65	
	Cube	7.00	19.65	
CONCRETE WITH 10% CRUMBS				
3.	Cube	5.00	17.65	**17.40**
	Cube	4.00	16.65	
	Cube	5.00	17.65	
	Cube	5.00	17.65	
CONCRETE WITH 15% CRUMBS				
4.	Cube	4.00	16.65	**15.90**
	Cube	3.00	15.65	
	Cube	3.00	15.65	
	Cube	3.00	15.65	
CONCRETE WITH 20% CRUMBS				
5.	Cube	3.00	15.65	**15.15**
	Cube	2.00	14.65	
	Cube	2.00	14.65	
	Cube	3.00	15.65	

Effect of Percentage of Crumbs on the 24 Hour Accelerated cured compressive strength of concrete



6.4 Ultrasonic Pulse Velocity Method (IS-13311:1992)

In Ultrasonic Pulse Velocity Method, the Ultrasonic pulse is generated by an electro acoustical transducer. When pulse is induced into the concrete from a transducer, it undergoes multiple reflections at the boundaries of the different material phases within the concrete. A complex system of stress wave is developed which includes longitudinal, shear and surface waves. The receiving transducer detects the onset of the longitudinal waves, which is the fastest.

The Ultrasonic Pulse Velocity Method could be used to establish:

(a) The homogeneity of concrete

(b) The presence of cracks, voids and other imperfections

(c) Changes in the structure of the concrete which may occur with time

(d) The quality of concrete in relation to standard requirements.

(e) The values of dynamic elastic modulus of the concrete.

The quality of concrete in terms of uniformity, incidence or absence of internal flaws, crack and segregation etc. can thus be assessed using the guidelines given in the following table:

S.No.	Pulse Velocity by Cross Probing (km/sec.)	Concrete quality grading
1.	Above 4.5	Excellent
2.	3.5 to 4.5	Good
3.	3.0 to 3.5	Medium
4.	Below 3.0	Doubtful

The Dynamic Modulus of Elasticity (E) of the concrete may be determined from pulse velocity and dynamic Poisson's ratio (μ) using the following relationship:

$$E = \frac{\rho(1+\mu)(1-2\mu)V^2}{1-\mu}$$

Where,

E = Dynamic Modulus of Elasticity in MPa.

ρ = Density of concrete in kg/m^3

V = Pulse velocity in km/sec.

μ = Poisson's Ratio (0.24)

Calculations of materials for cylinders are presented in Appendix A4

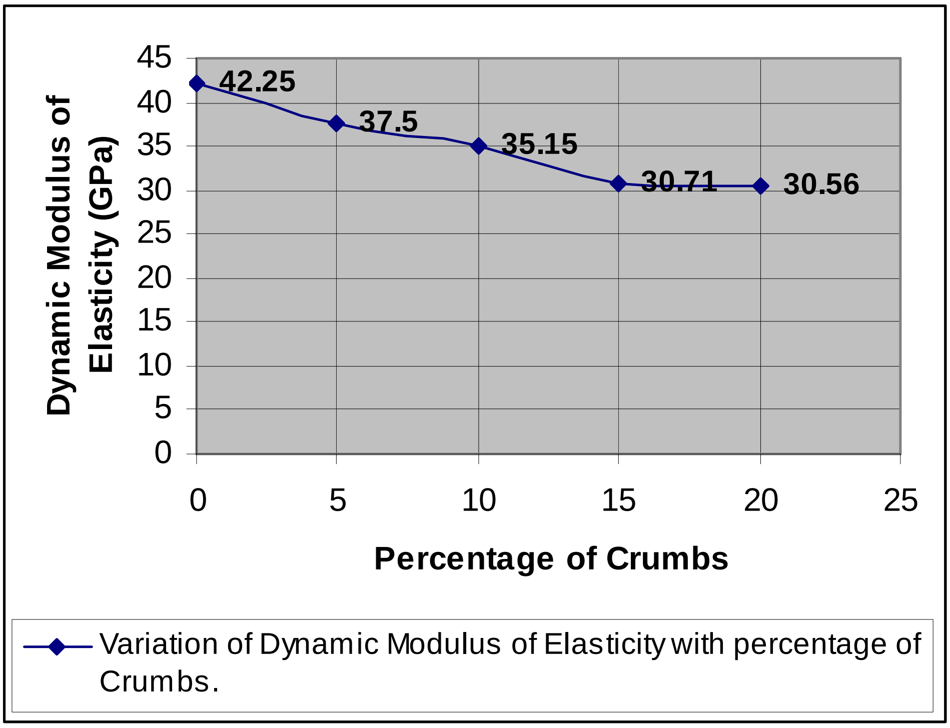
OBSERVATIONS

Specimen	Time (µs) (t)	Distance (m) (I)	Velocity (m/s) (V)	Weight (kg)
Control Mix				
Cylinder	34.2	0.150	4386	13.250
Cylinder	33.1	0.150	4532	13.400
Cylinder	33.9	0.150	4425	13.540
Concrete with 5% Crumbs				
Cylinder	35.9	0.150	4178	13.075
Cylinder	36.5	0.150	4109	13.025
Cylinder	33.3	0.150	4504	13.060
Concrete with 10% Crumbs				
Cylinder	38.6	0.150	3886	13.025
Cylinder	35.0	0.150	4285	13.010
Cylinder	36.2	0.150	4143	13.020
Concrete with 15% Crumbs				
Cylinder	38.6	0.150	3886	13.000
Cylinder	37.9	0.150	3958	12.900
Cylinder	38.9	0.150	3856	12.950
Concrete with 20% Crumbs				
Cylinder	38.5	0.150	3896	12.800
Cylinder	40.5	0.150	3703	12.750
Cylinder	37.5	0.150	4000	12.790

RESULT

Specimen	Mass (kg)	Volume (m^3)	Density (kg/m^3)	Velocity (m/sec)	Dynamic Modulus of Elasticity (GPa)	Average Modulus of Elasticity (GPa)
CONTROL MIX						
Cylinder	13.250	0.00530	2500.00	4386	40.78	**42.25**
Cylinder	13.400	0.00530	2528.30	4532	44.03	
Cylinder	13.540	0.00530	2554.72	4425	41.94	
CONCRETE WITH 5% CRUMBS						
Cylinder	13.075	0.00530	2466.98	4178	36.16	**37.50**
Cylinder	13.025	0.00530	2457.54	4109	35.03	
Cylinder	13.060	0.00530	2464.15	4504	42.32	
CONCRETE WITH 10% CRUMBS						
Cylinder	13.025	0.00530	2457.55	3886	31.47	**35.15**
Cylinder	13.010	0.00530	2454.72	4285	38.22	
Cylinder	13.020	0.00530	2456.60	4143	35.76	
CONCRETE WITH 15% CRUMBS						
Cylinder	13.000	0.00530	2452.83	3886	30.03	**30.17**
Cylinder	12.900	0.00530	2433.96	3958	31.39	
Cylinder	12.950	0.00530	2443.39	3856	30.72	
CONCRETE WITH 20% CRUMBS						
Cylinder	12.800	0.00530	2415.09	3896	30.99	**30.56**
Cylinder	12.750	0.00530	2405.66	3703	27.97	
Cylinder	12.790	0.00530	2413.20	4000	32.74	

Effect of percentage of Crumbs on the Dynamic Modulus of Elasticity



CHAPTER- 7

Effect of Admixture

7.1 Effect of Admixture & Crumbs on the 28 Days Compressive Strength of Concrete.

7.2 Effect of Admixture & Crumbs on the 1 year Compressive Strength of Concrete.

7.3 Effect of Admixture & Crumbs on the Dynamic Modulus of Elasticity of Concrete.

7.4 Effect of Admixture & Crumbs on the Flexural Strength of Concrete.

7.1 Effect of Admixture & Crumbs on the 28 Days Compressive Strength of Concrete

Admixture CEMWET SP 3000 was added to the concrete with crumbs to study its affect on the compressive strength. The percentage of crumbs was kept as 5% and 10%.

The dosage of admixture was varied as 0.5%, 1% and 1.5%.

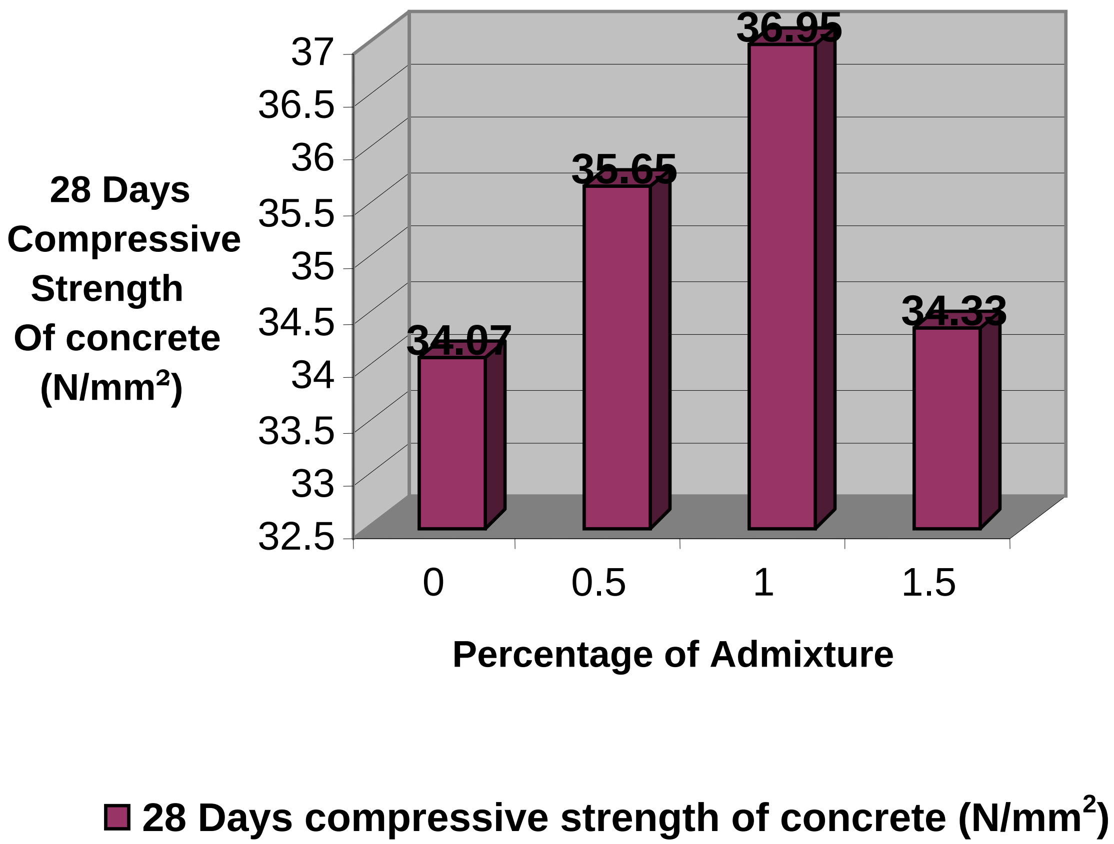
The calculations for mix proportion are presented in Appendix A5.

7.1 Effect of Admixture & Crumbs on the 28 Days Compressive Strength of Concrete

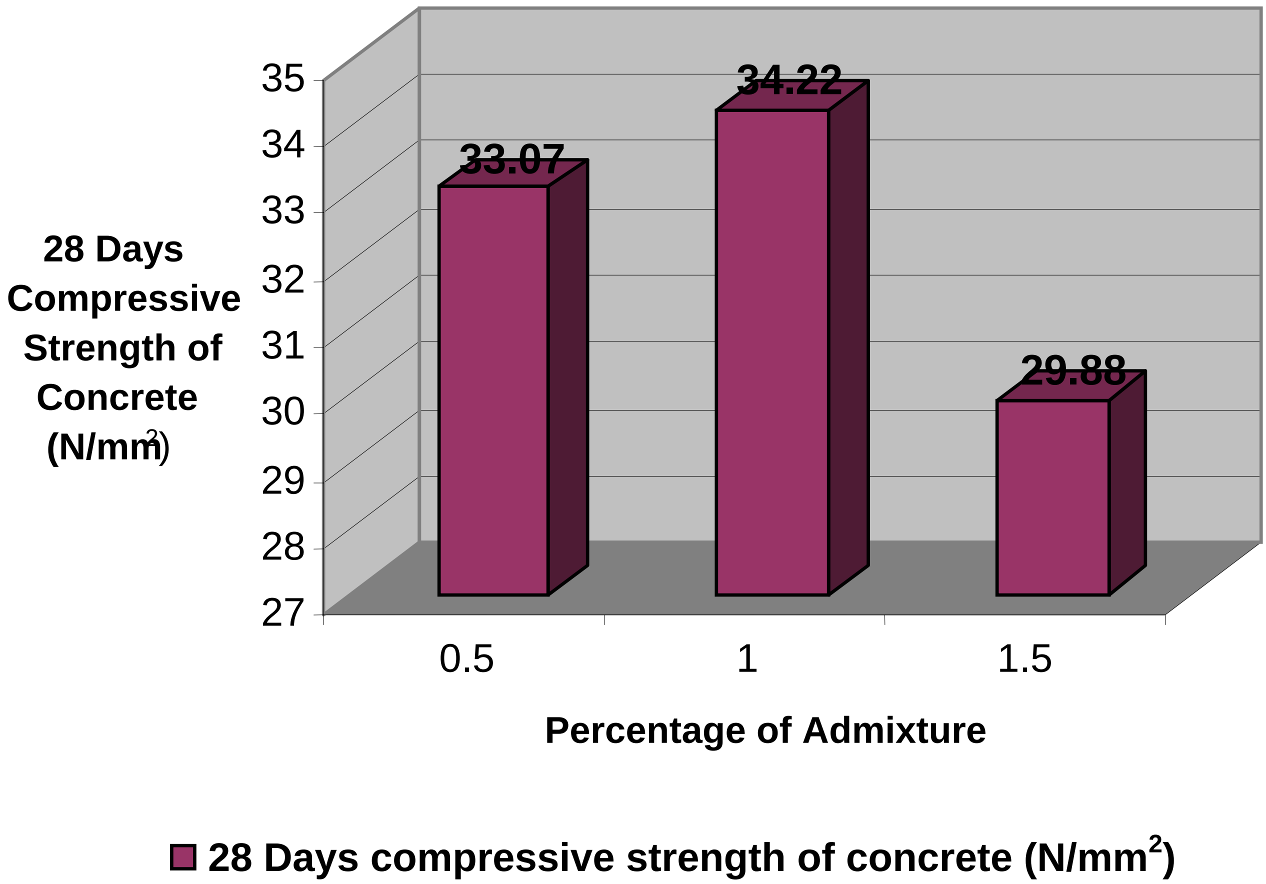
28 Days Compressive Strength of Concrete

S.No.	Specimen	28 Days Compressive Strength of Concrete (N/mm^2)	Average 28 Days Compressive Strength of Concrete (N/mm^2)
CONTROL MIX			
1.	Cube	35.35	**34.07**
	Cube	33.57	
	Cube	33.79	
	Cube	33.57	
CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE			
2.	Cube	35.32	**35.65**
	Cube	35.97	
	Cube	35.54	
	Cube	35.75	
CONCRETE WITHOUT CRUMBS & 1.0 % ADMIXTURE			
3.	Cube	37.06	**36.95**
	Cube	36.62	
	Cube	36.84	
	Cube	37.28	
CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE			
4.	Cube	34.44	**34.33**
	Cube	34.23	
	Cube	34.66	
	Cube	34.00	
CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE			
5.	Cube	34.40	**33.07**
	Cube	31.83	
	Cube	33.57	
	Cube	32.48	
CONCRETE WITH 5% CRUMBS & 1.0 % ADMIXTURE			
6.	Cube	34.66	**34.22**
	Cube	34.00	
	Cube	34.23	
	Cube	34.00	
CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE			
7.	Cube	30.08	**29.88**
	Cube	29.87	
	Cube	29.69	
	Cube	29.87	
CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE			
8.	Cube	34.44	**34.39**
	Cube	34.66	
	Cube	34.23	
	Cube	34.23	
CONCRETE WITH 10% CRUMBS & 1.0 % ADMIXTURE			
9.	Cube	34.44	**34.39**
	Cube	34.66	
	Cube	34.88	
	Cube	34.66	
CONCRETE WITH 10% CRUMBS & 1.5% ADMIXTURE			
10.	Cube	30.74	**30.90**
	Cube	30.96	
	Cube	31.18	
	Cube	30.74	

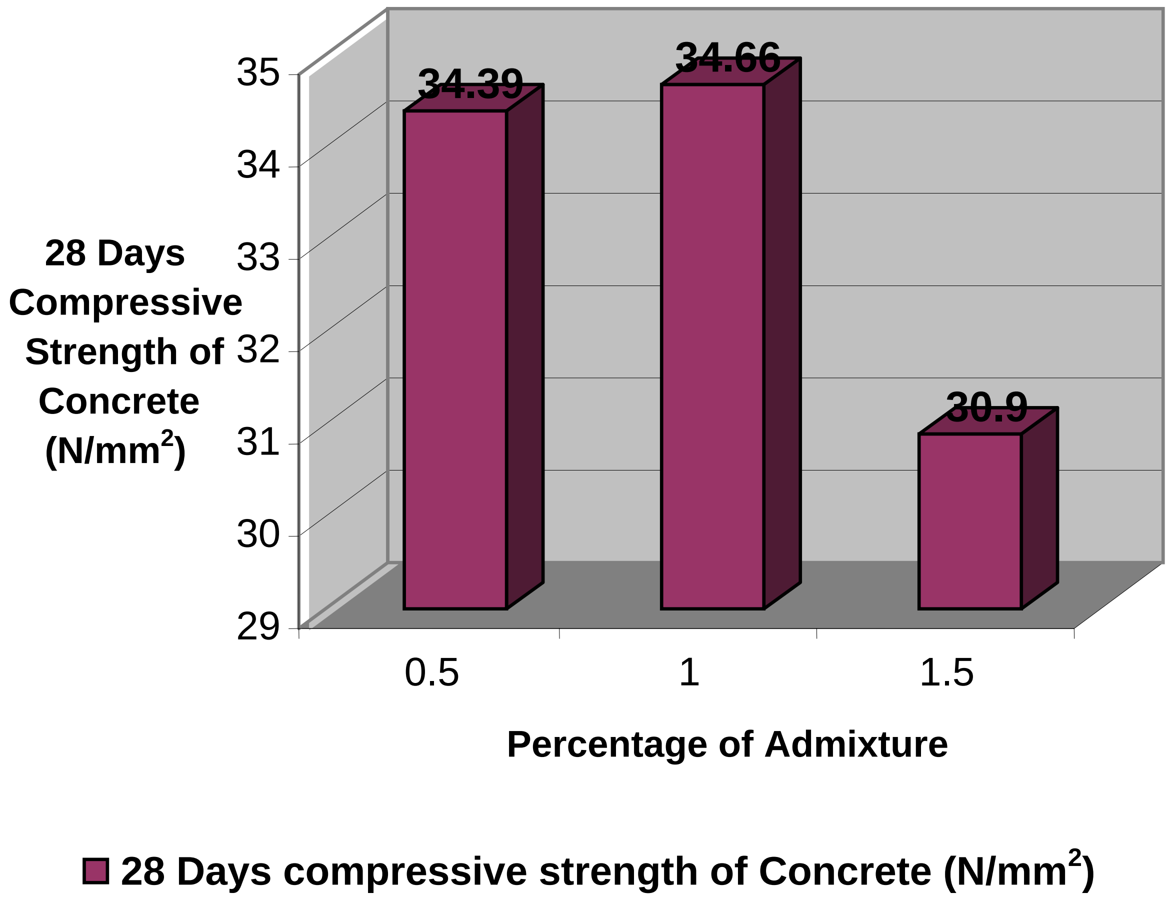
Effect of Percentage of Admixture on the Concrete without Crumbs



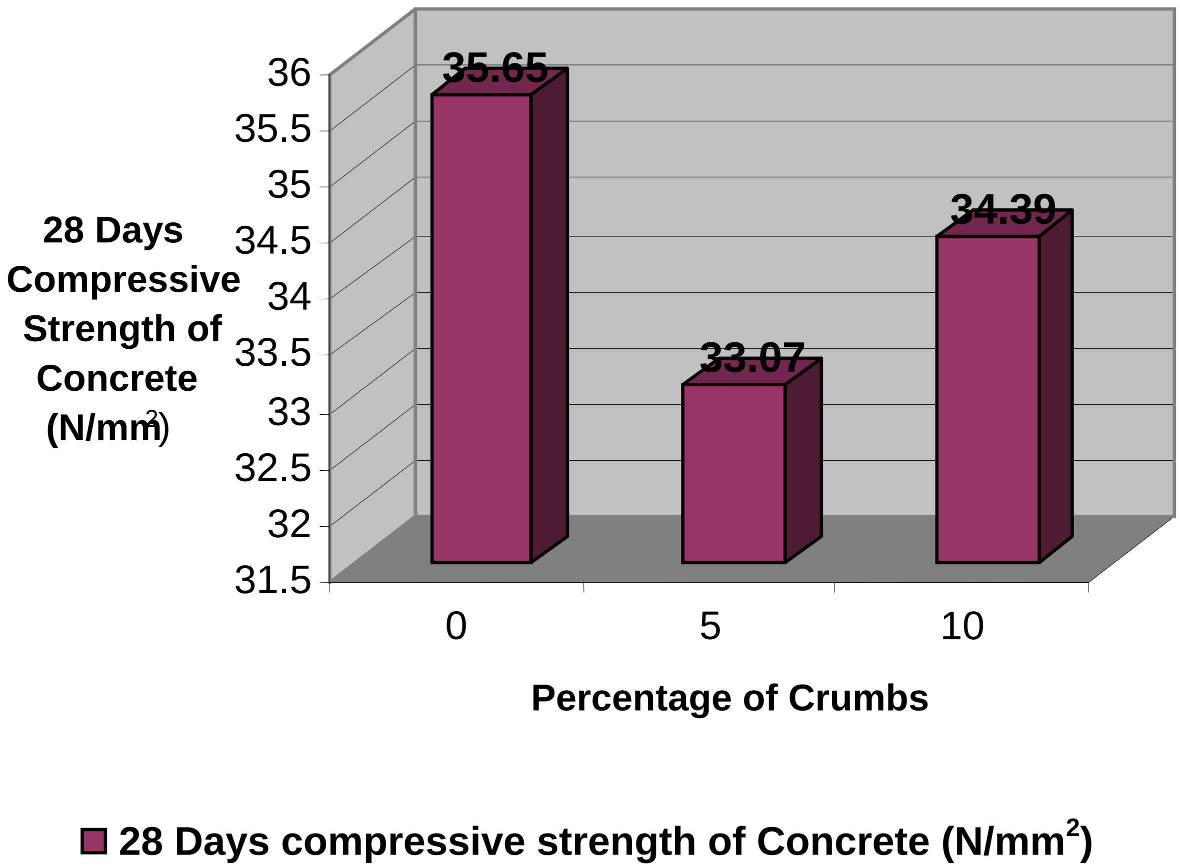
Effect of Admixture on the 28 Days Compressive Strength of Concrete with 5% Crumbs



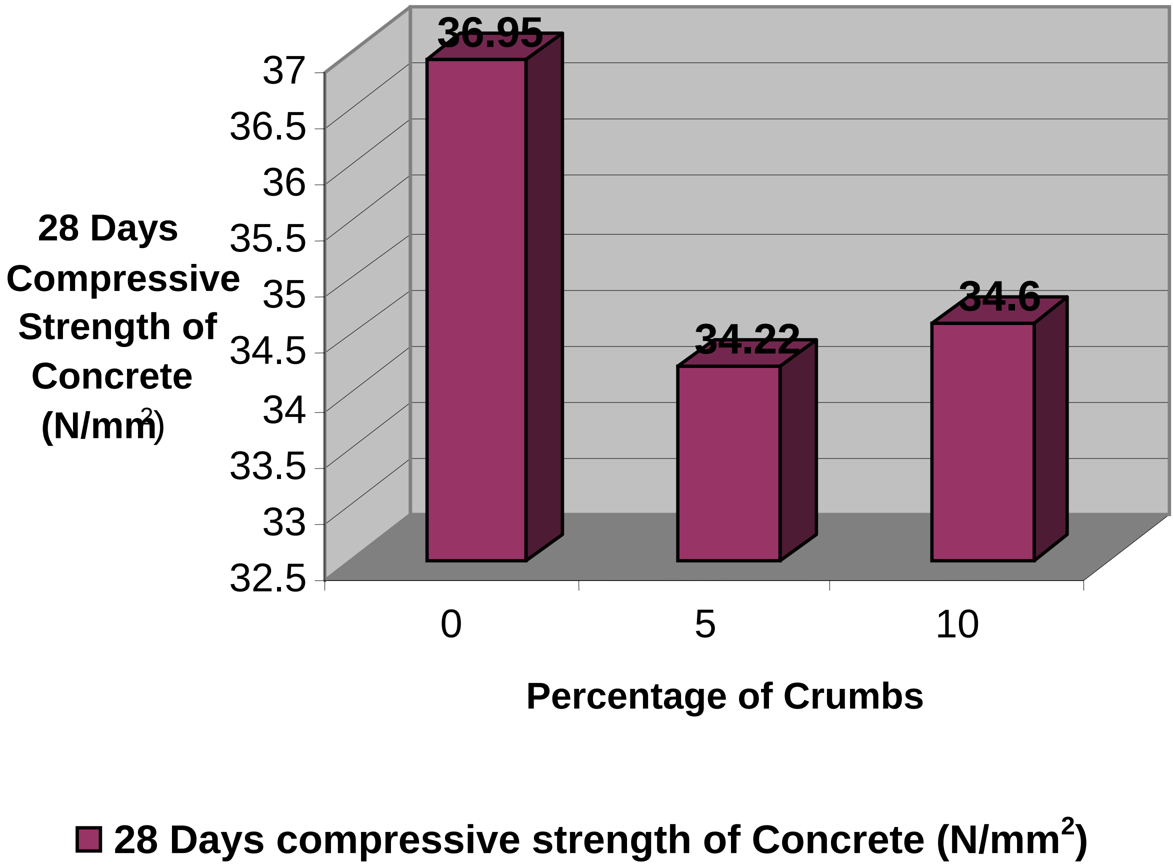
Effect of Admixture on the 28 Days Compressive Strength of Concrete with 10% Crumbs



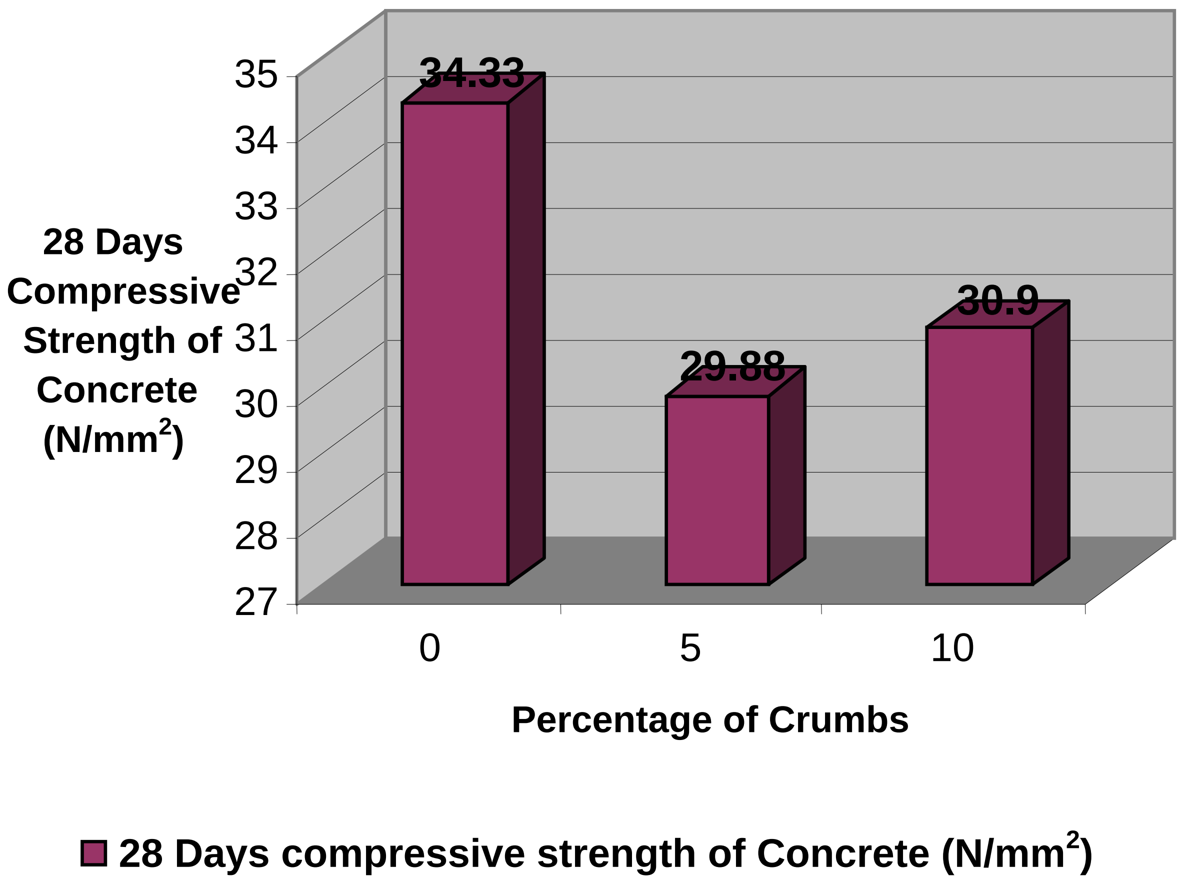
Effect of Percentage of Crumbs on the 28 Days Compressive Strength of Concrete with 0.5% Admixture



Effect of Percentage of Crumbs on the 28 Days Compressive Strength of Concrete with 1.0% Admixture



Effect of Percentage of Crumbs on the 28 Days Compressive Strength of Concrete with 1.5% Admixture



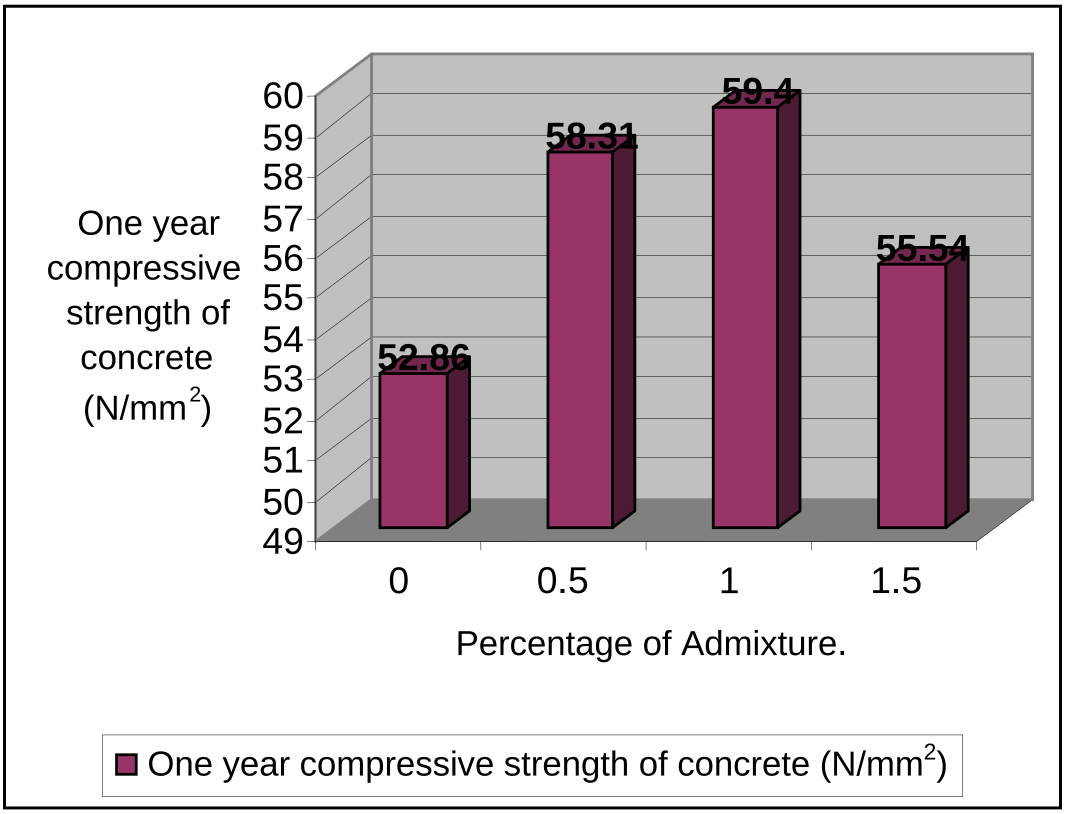
It is found that the use of 10% Crumbs with 1.0% admixture results in a 28 Days compressive strength 34.6 N/mm^2 as compared to 34.07 N/mm^2 strength of the control mix. The compressive strength has increased.

7.2 Effect of Admixture & Crumbs on the One Year Compressive Strength of Concrete

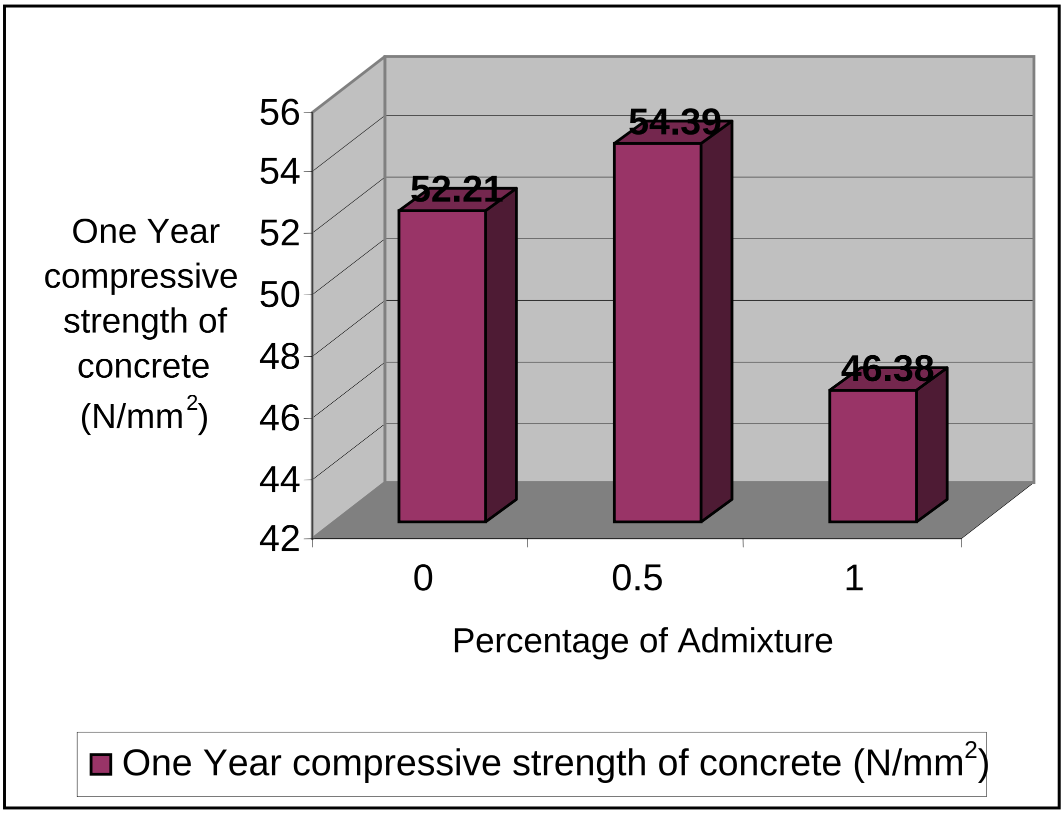
One Year Compressive Strength of Concrete

S.No.	Specimen	28 Days Compressive Strength of Concrete (N/mm^2)	Average 28 Days Compressive Strength of Concrete (N/mm^2)
CONTROL MIX			
1.	Cube	54.40	**52.86**
	Cube	52.32	
	Cube	50.14	
	Cube	54.40	
CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE			
2.	Cube	56.68	**58.31**
	Cube	58.86	
	Cube	58.86	
	Cube	58.86	
CONCRETE WITHOUT CRUMBS & 1.0 % ADMIXTURE			
3.	Cube	58.86	**59.40**
	Cube	56.68	
	Cube	61.04	
	Cube	61.04	
CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE			
4.	Cube	56.68	**55.54**
	Cube	56.68	
	Cube	54.40	
	Cube	54.40	
CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE			
5.	Cube	52.32	**52.21**
	Cube	52.10	
	Cube	51.89	
	Cube	52.54	
CONCRETE WITH 5% CRUMBS & 1.0 % ADMIXTURE			
6.	Cube	54.06	**54.39**
	Cube	54.50	
	Cube	54.72	
	Cube	54.28	
CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE			
7.	Cube	45.78	**46.38**
	Cube	45.99	
	Cube	45.78	
	Cube	47.96	
CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE			
8.	Cube	54.50	**54.39**
	Cube	54.28	
	Cube	54.06	
	Cube	54.72	
CONCRETE WITH 10% CRUMBS & 1.0 % ADMIXTURE			
9.	Cube	56.68	**55.65**
	Cube	54.72	
	Cube	54.50	
	Cube	56.68	
CONCRETE WITH 10% CRUMBS & 1.5% ADMIXTURE			
10.	Cube	47.96	**46.98**
	Cube	48.18	
	Cube	45.78	
	Cube	45.99	

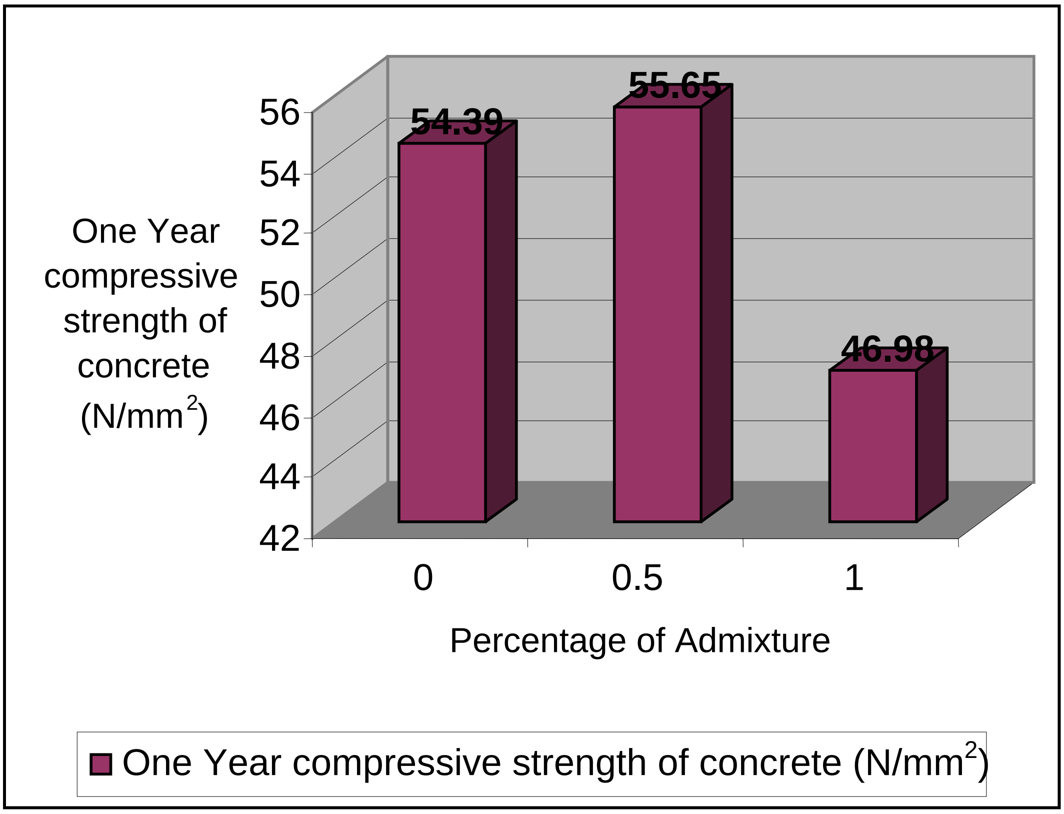
Effect of Percentage of Admixture on the Concrete without Crumbs



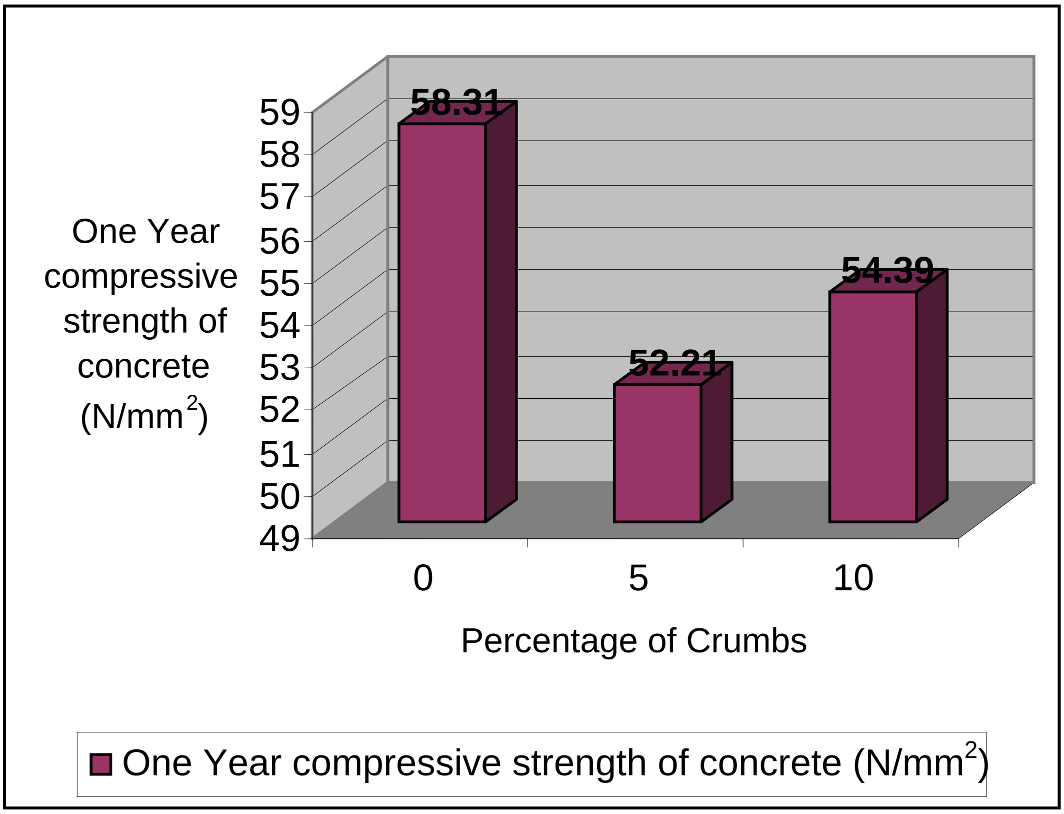
Effect of Admixture on the One Year Compressive Strength of Concrete with 5% Crumbs



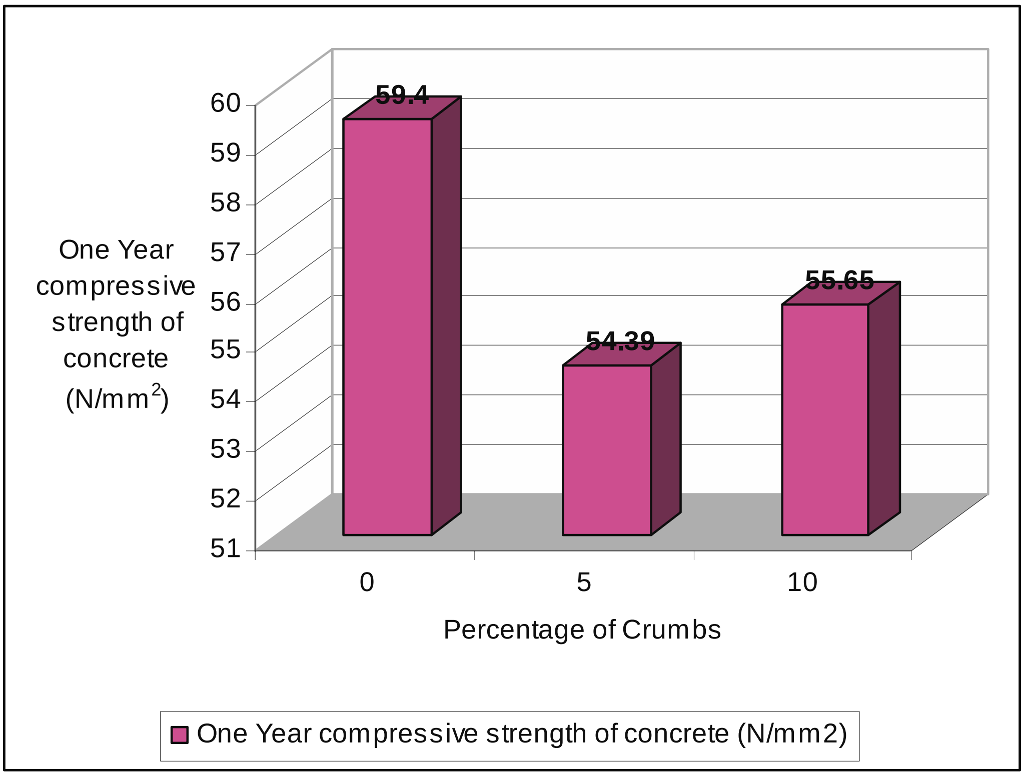
Effect of Admixture on the One Year Compressive Strength of Concrete with 10% Crumbs



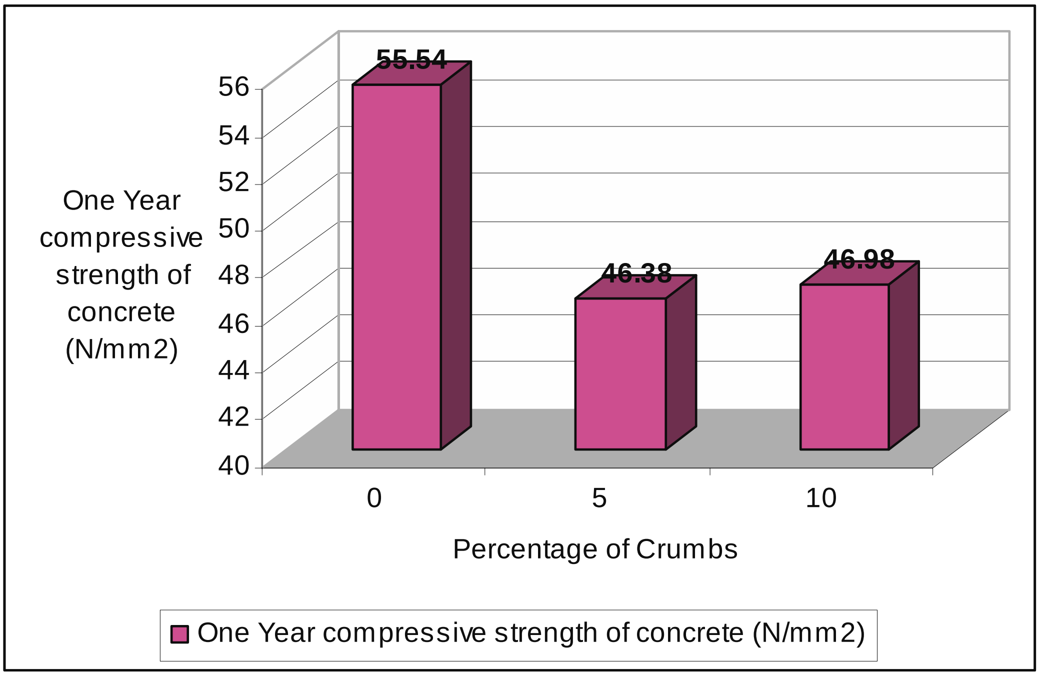
Effect of Percentage of Crumbs on the One Year Compressive Strength of Concrete with 0.5% Admixture



Effect of Percentage of Crumbs on the One Year Compressive Strength of Concrete with 1.0% Admixture



Effect of Percentage of Crumbs on the One Year Compressive Strength of Concrete with 1.5% Admixture



It is noted that the use of 10% of crumbs with 1% admixture has resulted in a one year compressive strength 55.65 N/mm^2 as compared to 52.86 N/mm^2 one year strength of control mix. The one year strength with the use of 10% crumbs is also more than control mix.

7.3 Modulus of Elasticity of Concrete By Ultrasonic Pulse Velocity Method (Dynamic Modulus of Elasticity)

Calculations for mix proportion for cylinders with admixture are presented in Appendix A6.

OBSERVATIONS

Specimen	Time (µs) (t)	Distance (m) (I)	Velocity (m/s) (V)	Weight (kg)
Control Mix				
Cylinder	36.5	0.150	4109	13.095
Cylinder	36.0	0.150	4166	13.075
Concrete Mix with 0.5% Admixture & 0% Crumbs				
Cylinder	35.5	0.150	4225	13.100
Cylinder	35.2	0.150	4214	13.095
Concrete Mix with 1.0% Admixture & 0% Crumbs				
Cylinder	33.6	0.150	4464	13.125
Cylinder	35.0	0.150	4286	13.100
Concrete Mix with 1.5% Admixture & 0% Crumbs				
Cylinder	36.0	0.150	4167	13.075
Cylinder	35.8	0.150	4186	13.100
Concrete Mix with 0.5% Admixture & 5.0% Crumbs				
Cylinder	36.3	0.150	4132	13.010
Cylinder	36.1	0.150	4155	13.020
Concrete Mix with 1.0% Admixture & 5.0% Crumbs				
Cylinder	36.5	0.150	4109	13.025
Cylinder	36.0	0.150	4167	13.020
Concrete Mix with 1.5% Admixture & 5.0% Crumbs				
Cylinder	37.5	0.150	4000	13.015
Cylinder	37.3	0.150	4021	13.030
Concrete Mix with 0.5% Admixture & 10% Crumbs				
Cylinder	36.2	0.150	4143	13.00
Cylinder	36.5	0.150	4109	13.010
Concrete Mix with 1.0% Admixture & 10% Crumbs				
Cylinder	36.3	0.150	4132	13.005
Cylinder	36.6	0.150	4098	13.000
Concrete Mix with 1.5% Admixture & 10% Crumbs				
Cylinder	37.2	0.150	4032	13.015
Cylinder	37.1	0.150	4043	13.010

RESULTS

Specimen	Mass (kg)	Volume (m^3)	Density (kg/m^3)	Velocity (m/sec)	Dynamic Modulus of Elasticity (GPa)	Average Modulus of Elasticity (GPa)
CONTROL MIX						
Cylinder	13.095	0.00530	2470.76	4109	35.39	**35.86**
Cylinder	13.075	0.00530	2466.98	4167	36.33	
CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE						
Cylinder	13.100	0.00530	2471.69	4225	37.43	**37.32**
Cylinder	13.095	0.00530	2470.75	4214	37.22	
CONCRETE WITHOUT CRUMBS & 1.0% ADMIXTURE						
Cylinder	13.125	0.00530	2476.41	4464	41.86	**40.19**
Cylinder	13.100	0.00530	2471.69	4286	38.52	
CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE						
Cylinder	13.075	0.00530	2466.98	4166	36.32	**36.55**
Cylinder	13.100	0.00530	2471.69	4189	36.79	
CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE						
Cylinder	13.010	0.00530	2454.72	4132	35.56	**35.77**
Cylinder	13.020	0.00530	2456.60	4155	35.98	
CONCRETE WITH 5% CRUMBS & 1.0% ADMIXTURE						
Cylinder	13.025	0.00530	2457.55	4109	35.20	**35.68**
Cylinder	13.020	0.00530	2456.60	4167	36.17	
CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE						
Cylinder	13.015	0.00530	2455.66	4000	33.34	**33.53**
Cylinder	13.030	0.00530	2458.49	4021	33.72	
CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE						
Cylinder	13.000	0.00530	2452.83	4143	35.72	**35.44**
Cylinder	13.010	0.00530	2454.72	4109	35.16	
CONCRETE WITH 10% CRUMBS & 1.0% ADMIXTURE						
Cylinder	13.005	0.00530	2453.77	4132	35.54	**35.24**
Cylinder	13.000	0.00530	2452.83	4098	34.94	
CONCRETE WITH 10% CRUMBS & 1.5% ADMIXTURE						
Cylinder	13.015	0.00530	2455.66	4032	33.87	**33.95**
Cylinder	13.010	0.00530	2454.72	4043	34.04	

7.4 Effect of Percentage of Admixture & Crumbs on the Flexural Strength of Concrete

Flexural Strength of Concrete

The theoretical maximum tensile stress reached at the bottom fibers of a test Beam is known as the **Modulus of Rupture,** which is relevant to the design of highways and air field pavements. A concrete road slab is called upon to resist tensile stresses from two principal sources-Wheel load and Volume change in concrete. Wheel load may cause high tensile stresses due to bending, when there is inadequate sub grade support. Volume changes, resulting from changes in temperature and moisture may produce tensile stresses due to warping and due to movement of slab along sub grade.

Flexural Strength of concrete in terms of Modulus of Rupture can be calculated by using the relation:-

$$\sigma = Pl / bd^3$$

Where,

P= Load in Newton
L= Supported Span
b= Width of Beam
d= Depth of Beam

Calculations of mix proportions for beam specimens are presented in Appendix-A7

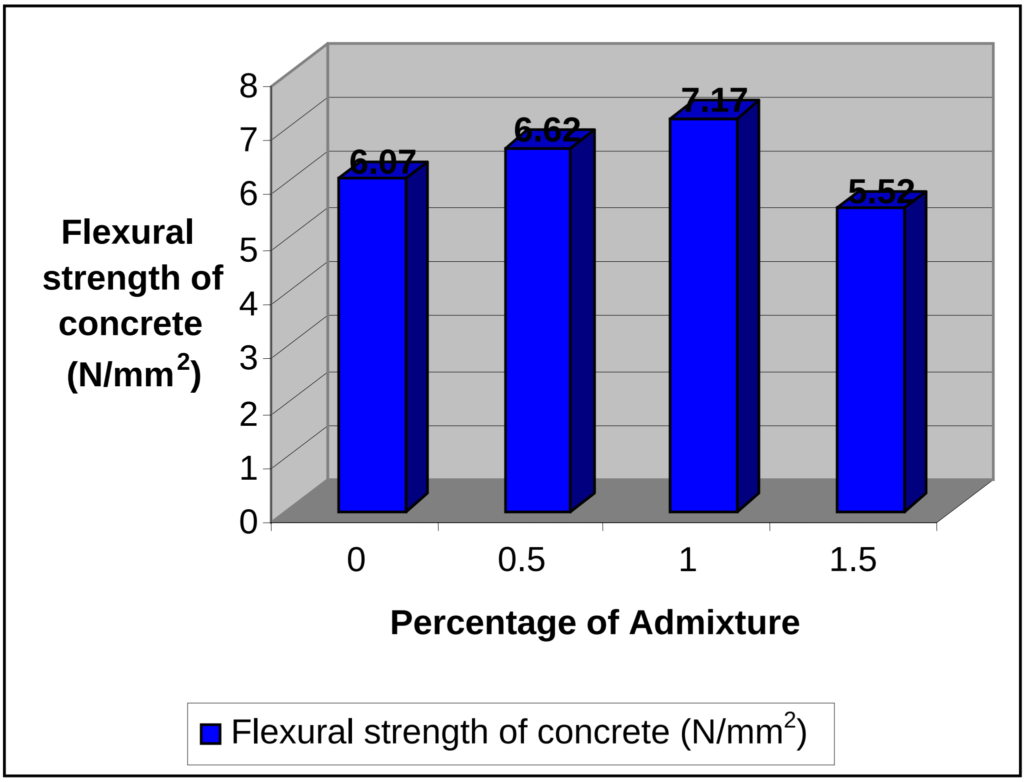
Type of Loading – **Two Point Loading** (At third point of span)

Size of Beam specimen = **100mm×100mm×500mm**

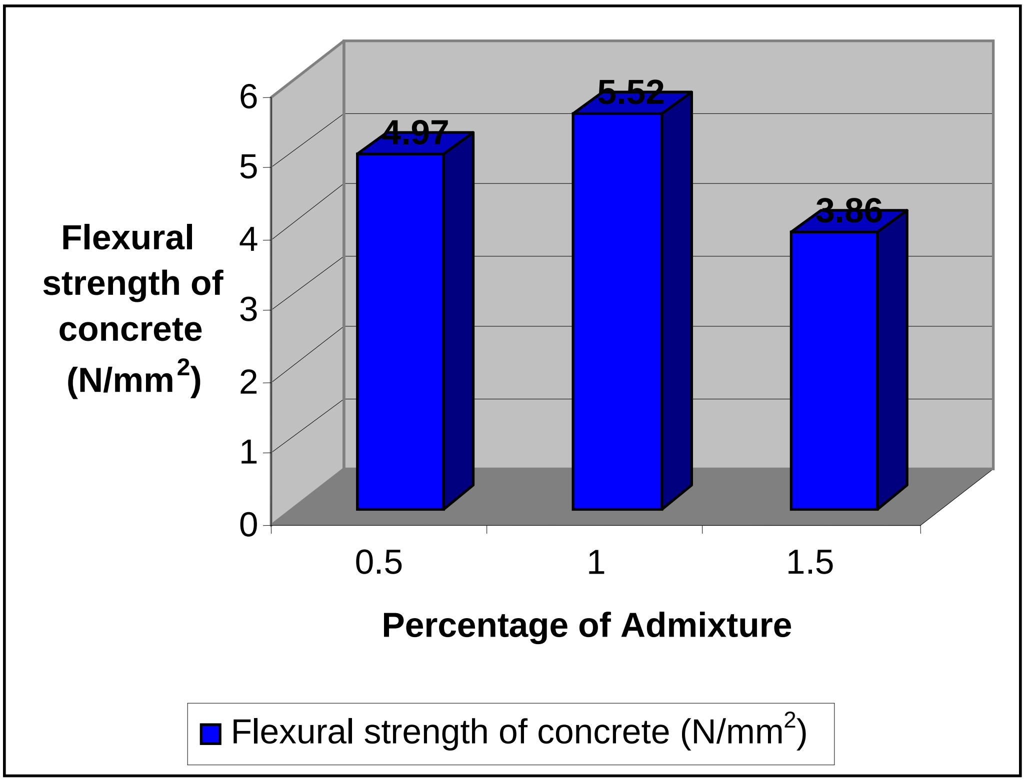
Supported span of the Beam Specimen = **450mm**

S.No	Specimen Specification	Load (Newton)	Modulus of Rupture	Average value of Modulus of Rupture
1.	**Control Mix Concrete**	9810	4.42	6.07
		14715	6.62	
		14715	6.62	
		14715	6.62	
2.	**Concrete without Crumbs & 0.5 % Admixture**	14715	6.62	6.62
		14715	6.62	
		9810	4.42	
		19620	8.83	
3.	**Concrete without Crumbs & 1.0 % Admixture**	19620	8.83	7.17
		14715	6.62	
		14715	6.62	
		14715	6.62	
4.	**Concrete without Crumbs & 1.5 % Admixture**	9810	4.42	5.52
		14715	6.62	
		14715	6.62	
		9810	4.42	
5.	**Concrete with 5% Crumbs & 0.5 % Admixture**	9810	4.42	4.97
		9810	4.42	
		9810	4.42	
		14715	6.62	
6.	**Concrete with 5% Crumbs & 1.0 % Admixture**	14715	6.62	5.52
		14715	6.62	
		9810	4.42	
		9810	4.42	
7.	**Concrete with 5% Crumbs & 1.5 % Admixture.**	9810	4.42	3.86
		9810	4.42	
		9810	4.42	
		4905	2.21	
8.	**Concrete with 10% Crumbs & 0.5 % Admixture**	14715	6.62	4.97
		9810	4.42	
		9810	4.42	
		9810	4.42	
9.	**Concrete with 10% Crumbs & 1.0 % Admixture**	9810	4.42	5.52
		14715	6.62	
		9810	4.42	
		14715	6.62	
10.	**Concrete with 10% Crumbs & 1.5 % Admixture**	4905	2.21	3.32
		9810	4.42	
		4905	2.21	
		9810	4.42	

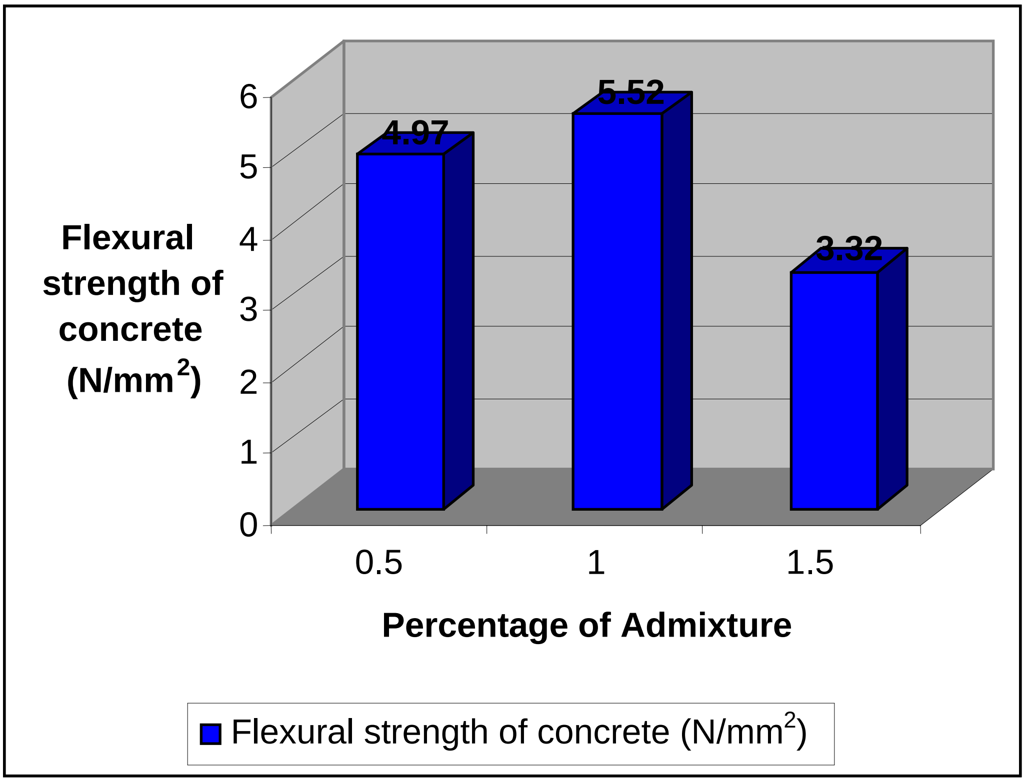
Effect of Percentage of Admixture on the Flexural Strength of Concrete without Crumbs



Effect of Percentage of Admixture on the Flexural Strength of Concrete with 5% Crumbs



Effect of Percentage of Admixture on the Flexural Strength of Concrete with 10% Crumbs



Comparison of Flexural Strength with the IS: 456: 2000

As per **IS: 456: 2000**, the Flexural Strength of Concrete is given by the relation:-

$$\sigma = 0.7 \sqrt{f_{ck}}$$

Where,

f_{ck} = Characteristic Compressive Strength of Concrete

= 20 N/mm^2 **(Used in the test)**

S.No.	Mix	Flexural Strength of Concrete as per IS: 456:2000 (MPa)	Flexural Strength of Concrete as per actual test (MPa)
1.	Concrete without Crumbs & admixture	**3.13**	**6.07**
2.	Concrete without Crumbs & 0.5% admixture	**3.13**	**6.62**
3.	Concrete without Crumbs & 1.0% admixture	**3.13**	**7.17**
4.	Concrete without Crumbs & 1.5% admixture	**3.13**	**5.52**
5.	Concrete with 5% Crumbs & 0.5% admixture	**3.13**	**4.97**
6.	Concrete with 5% Crumbs & 1.0% admixture	**3.13**	**5.52**
7.	Concrete with 5% Crumbs & 1.5% admixture	**3.13**	**3.86**
8.	Concrete with 10% Crumbs & 0.5% admixture	**3.13**	**4.97**
9.	Concrete with 10% Crumbs & 1.0% admixture	**3.13**	**5.52**
10.	Concrete with 10% Crumbs & 1.5% admixture	**3.13**	**3.32**

It is clear from the above table that with the addition of 0.5% and 1.0% Admixture in the concrete, the value of Flexural Strength of concrete increases, but with 1.5% admixture, it decreases. With the addition of Crumbs, the flexural strength decreases. For concrete with 10% Crumbs and 1.0% admixture, the flexural strength is almost comparable to control mix.

CHAPTER-8

<u>COST ANALYSIS</u>

Case-I

(<u>Concrete without Crumbs & Admixture</u>)

Let,

Length of Roadway = 1.0 km
Width of Roadway = 3.75 m (Single Lane)
Thickness of Roadway = 15.0 cm
Grade of Concrete = M20
Type of Cement = ACC (OPC) (Specific Gravity -3.05)
Size of Coarse Aggregate = 20mm
Specific Gravity of Coarse Aggregate = 2.8
Specific Gravity of Fine Aggregate = 2.44
Type of Admixture = CEMWET SP 3000 (Super Plasticizer)
Specific Gravity of Admixture = 1.22

As per the Mix Design by Indian Standard, mix proportion for M20 grade concrete comes out to be:-

Water	Cement	Fine Aggregate	Coarse Aggregate
0.480	1.0	1.430	3.400

Now,

Volume of Concrete required for the construction of Road is
$= 1000 \times 3.75 \times 0.15 = 562.5\ m^3$

So,

Mass = 562.5 × 24 × 1000/9.81 = 1376146.789 kg

Then,

Cement Required = 1/ (1+ 1.430 + 3.400) × 1376146.789 = 236045.762 kg
= 236045.762 / 50 = 4721
Bags

Water Required = 0.480 / (1+ 1.430 + 3.400) × 1376146.789 = 113301.966kg

Fine Aggregate Required = 1.430 / (1+ 1.430 + 3.400) × 1376146.789 = 337545.439 kg
$= 120.56\ m^3$

Coarse Aggregate Required = 3.400 / (1+ 1.430 + 3.400) × 1376146.789 = 802555.589
kg
$= 328.92\ m^3$

Now,

Cost of Cement @ Rs.250 / Bag = 4721×250 = Rs.11, 80,250 /-
Cost of Fine Aggregate @ Rs.350 / m^3 = 120.56×350 = Rs.42, 196 /-
Cost of Coarse Aggregate @ Rs.200 / m^3 = 328.92×200 = Rs.65, 784 /-

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Total Cost = Rs.12, 88,230 /-
(Rates as per DSR)

CASE 2

(Concrete with Crumbs & Admixture)

If we replace 10% of Fine Aggregate with Crumbs and 1.0% of Cement with Admixture, then the total cost comes out to be:

Now,

Quantity of Crumbs = 10% of Quantity of Fine Aggregate

= 10% of 337545.439 kg = 33754.5439 kg

So,

Net quantity of Fine Aggregate added

= 337545.439 kg – 33754.5439kg

= 303790.895 kg

= 108.50 m^3

Similarly,

Quantity of Admixture added = 1.0% of Quantity of Cement

= 1.0% of 236045.762 kg

= 1935 m^3

= 1935 liters

Then,

Net quantity of Cement added = 236045.762 kg – 2360.458 kg

= 233685.305 kg

= 4674 Bags

Now,

Cost of Cement @ Rs.250/Bag = 4674 x 250	Rs.11, 68,428/-
Cost of Fine Aggregate @ Rs.350/m^3 = 108.50x350	Rs.37, 975/-
Cost of Coarse Aggregate @ Rs.200/-m^3	Rs.65, 784/-
Cost of Admixture @ Rs.30/litre = 1935x30	Rs.58, 050/-
Total Cost	Rs.13, 30,237/-

Therefore,

Percentage increase in cost = (Rs.13, 30,237 – Rs.12,88,230)/Rs.13,30,237/-

= 3.26%

CONCLUSIONS

1. Improper disposal of the tyre waste can result in serious health hazard to the public.

2. It is clear from the Graph on page number ……that Crumbs having size > 4.75 mm, gives higher strength of Concrete when 5% of Fine Aggregate is replaced by this size of Crumbs in the Concrete Mix. Hence Crumbs of size > 4.75mm only will be used in the rest of the laboratory investigations.

3. A comparative study of compressive strength at 28 days and 7 days shows that:

a) For 0%, 5% and 10% crumbs, the 28 days strength is much higher than the 7 day strength.

b) For 15% and 20% crumbs, the 28 days strength is same as 7 days strength.

This shows that the use of 15% or more crumbs is not going to give good results.

4. The Dynamic Modulus of Elasticity of concrete reduces as the percentage of Crumbs is increased. The use of 15% and 20% Crumbs gives almost the same value, showing it to be the lowest possible value, as these percentages result in very low strengths also.

5. It is found that the use of 10% Crumbs with 1.0% admixture results in a 28 Days compressive strength 34.6 N/mm^2 as compared to 34.07 N/mm^2 strength of the control mix. The compressive strength has increased.

6. It is noted that the use of 10% of crumbs with 1.0% admixture has resulted in a one year compressive strength 55.65 N/mm^2 as compared to 52.86 N/mm^2 one year strength of control mix. The one year strength with the use of 10% crumbs is also more than control mix.

7. The Dynamic Modulus of Elasticity for concrete, with 5% Crumbs and 10% Crumbs, using 0.5% and 1.0% admixture are in the range of 35.24 to 35.77 GPa. These values compare very well with the value 35.86 GPa for the control mix. Hence, the use of 10% Crumbs with admixture gives the same Dynamic Modulus of Elasticity as of the control mix.

8. It is clear from the above table on page number…….. that with the addition of 0.5% and 1.0% Admixture in the concrete, the value of Flexural Strength of concrete increases, but with 1.5% admixture, it decreases. With the addition of Crumbs, the flexural strength decreases. For concrete with 10% Crumbs and 1.0% admixture, the flexural strength is almost comparable to control mix.

9. The use of 10% Crumbs results in a cost increase of 3.26%.

From the above conclusion it is seen that 10% fine aggregate can be safely replaced by used tyre Crumbs of size greater than 4.75 mm, but less than about 6.0 mm, if a suitable admixture is used. The compressive strength, flexural strength and dynamic modulus of elasticity are not much affected. After one year, the compressive strength of concrete with 10% Crumbs is found to be even greater than control mix.

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APPENDIX – A1

CONTROL MIX

Volume of concrete required for casting 3 cubes with 10% compensation is given as

$$= 3x\ (0.15)^3 \text{ x } 1.1 = 0.0121 \text{ m}^3$$

So,

Mass = 29.60 kg

Now

Cement required = 1/ (1+1.430+3.400) x 29.60 = 5.077 kg

Water required= 0.48/ (1+1.430+3.400) x29.60 = 2.437 kg

Fine Aggregate required = 1.430/ (1+1.430+3.400) x29.60 = 7.260kg

Coarse Aggregate required = 3.400/ (1+1.430+3.400) x29.60 = 17.252 kg

Now,

Extra water added for absorption of Fine aggregate = 1% of F.A. Quantity

= 1% of 7.250 kg = 0.0726 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of C.A. Quantity

= 0.5% of 17.262 kg = 0.0863 kg

So,

Total extra quantity of Water added = 0.07256 + 0.0863 = 0.159 kg

Then,

Total quantity of Water added in the mix = 2.437+0.159=2.595 kg

Therefore,

Actual quantity of Fine Aggregate required = 7.260-0.0726=7.187 kg

Actual quantity of Coarse Aggregate required = 17.262-0.0863 = 17.176 kg

Final Mix proportion per batch is

Water	Cement	Fine Aggregate	Coarse Aggregate
2.595 kg	5.077 kg	7.187 kg	17.176 kg

\

CONCRETE WITH 5% CRUMBS

Volume of concrete required for casting 3 cubes with 10% compensation is given as

$= 3x (0.15)^3 \text{ x } 1.1 = 0.0121 \text{ m}^3$

So, Mass = 29.60 kg

Now, Cement required = 1/ (1 + 1.430 + 3.400) x 29.60 = 5.077 kg

Water required = 0.48/ (1+1.430 + 3.400) x 29.60 = 2.437 kg

Fine Aggregate required = 1.430/ (1+1.430+3.400) x29.60 = 7.260kg

Coarse Aggregate required = 3.400/ (1+1.430+3.400) x29.60 = 17.262kg

Then, Quantity of Crumbs required = 5% of Quantity of Fine Aggregate

= 5% of 7.260 kg = 0.363 kg

So,

Net quantity of Fine Aggregate required = 7.260–0.363 = 6.897 kg

Now, Extra water added for absorption of Fine aggregate = 1% of F.A. Quantity

= 1% of 6.897 kg = 0.0689 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of C.A. Quantity

= 0.5% of 17.262 kg = 0.0863 kg

So, Total extra quantity of Water added = 0.155 kg

Then, Total quantity of water added in the mix = 2.437 + 0.155 = 2.592 kg

Therefore, Actual W/C ratio = 2.592/5.077 = 0.51

Also, Actual quantity of Fine Aggregate required= 6.897 – 0.0689 = 6.828 kg

Actual quantity of Coarse Aggregate required = 17.262 – 0.0863 = 17.176kg

So,

Final Mix proportion per batch is

Water	Cement	Fine Aggregate	Coarse Aggregate	Crumbs
2.592 kg	5.077 kg	6.828 kg	17.176 kg	0.363 kg

APPENDIX – A2

CONTROL MIX

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 20% compensation

$$= 4 \times (150)^3 \times 1.2 = 0.0162\ m^3$$

So,

Mass = 0.0162 × 24 × 1000/9.81 = 39.633 kg

Then,

Cement Required = 1/ (1+ 1.437 + 3.263) × 39.633 = 6.953 kg

Water Required = 0.480 / (1+ 1.437 + 3.263) × 39.633 = 3.338 kg

Fine Aggregate Required = 1.437 / (1+ 1.437 + 3.263) × 39.633 = 9.992 kg

Coarse Aggregate Required = 3.263 / (1+ 1.437 + 3.263) × 39.633 = 22.668 kg

Now,

Extra water added for absorption of Coarse Aggregate = 0.5% of 22.668 kg
= 0.114 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 9.992 kg
= 0.099 kg

Total extra water added = 0.114 + 0.099 = 0.214 kg

Total water added to Concrete = 3.338 + 0.214 = 3.552 kg

Therefore,

Actual quantity of Coarse Aggregate required = 22.688 – 0.114 = 22.574 kg

Actual quantity of Fine Aggregate required = 9.992 – 0.099 = 9.893 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 22.574 kg
= 4.515 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}
3.552 kg	6.953 kg	9.893 kg	16.059 kg	4.515 kg

CONCRETE WITH 5% CRUMBS

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 20% compensation

$$= 4 \times (150)^3 \times 1.2 = 0.0162 \text{ m}^3$$

So,

Mass = 0.0162 × 24 × 1000/9.81 = 39.633 kg

Then,

Cement Required = 1/ (1+ 1.437 + 3.263) × 39.633 = 6.953 kg

Water Required = 0.480 / (1+ 1.437 + 3.263) × 39.633 = 3.338 kg

Fine Aggregate Required = 1.437 / (1+ 1.437 + 3.263) × 39.633 = 9.992 kg

Coarse Aggregate Required = 3.263 / (1+ 1.437 + 3.263) × 39.633 = 22.668 kg

Now,

Quantity of Crumbs added = 5% of 9.992 kg = 0.500 kg

So,

Quantity of Fine Aggregate required = 9.992 – 0.500 = 9.493 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 22.668 kg
= 0.114 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 9.493 kg
= 0.0950 kg

Total extra water added = 0.114 + 0.0950 = 0.209 kg

Total water added to Concrete = 3.338 + 0.209 = 3.547 kg

Therefore,

Actual quantity of Coarse Aggregate required = 22.688 – 0.114 = 22.574 kg

Actual quantity of Fine Aggregate required = 9.493 – 0.0950 = 9.398 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 22.574 kg
= 4.515 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
3.547 kg	6.953 kg	9.398 kg	18.059 kg	4.515 kg	0.500 kg

CONCRETE WITH 10% CRUMBS

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 20% compensation

$$= 4 \times (150)^3 \times 1.2 = 0.0162 \text{ m}^3$$

So,

Mass = 0.0162 × 24 × 1000/9.81 = 39.633 kg

Then,

Cement Required = 1/ (1+ 1.437 + 3.263) × 39.633 = 6.953 kg

Water Required = 0.480 / (1+ 1.437 + 3.263) × 39.633 = 3.338 kg

Fine Aggregate Required = 1.437 / (1+ 1.437 + 3.263) × 39.633 = 9.992 kg

Coarse Aggregate Required = 3.263 / (1+ 1.437 + 3.263) × 39.633 = 22.668 kg

Now,

Quantity of Crumbs added = 10% of 9.992 kg = 0.999 kg

So,

Quantity of Fine Aggregate required = 9.992 – 0.999 = 8.993 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 22.668 kg
= 0.114 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 8.993 kg
= 0.0899 kg

Total extra water added = 0.114 + 0.0899 = 0.204 kg

Total water added to Concrete = 3.338 + 0.204 = 3.542 kg

Therefore,

Actual quantity of Coarse Aggregate required = 22.688 – 0.114 = 22.574 kg

Actual quantity of Fine Aggregate required = 8.993 – 0.0899 = 8.903 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 22.574 kg
= 4.515 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
3.542 kg	6.953 kg	8.903 kg	18.059 kg	4.515 kg	0.999 kg

CONCRETE WITH 15% CRUMBS

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 20% compensation

$$= 4 \times (150)^3 \times 1.2 = 0.0162 \text{ m}^3$$

So,

Mass = 0.0162 × 24 × 1000/9.81 = 39.633 kg

Then,

Cement Required = 1/ (1+ 1.437 + 3.263) × 39.633 = 6.953 kg

Water Required = 0.480 / (1+ 1.437 + 3.263) × 39.633 = 3.338 kg

Fine Aggregate Required = 1.437 / (1+ 1.437 + 3.263) × 39.633 = 9.992 kg

Coarse Aggregate Required = 3.263 / (1+ 1.437 + 3.263) × 39.633 = 22.668 kg

Now,

Quantity of Crumbs added = 15% of 9.992 kg = 1.500 kg

So,

Quantity of Fine Aggregate required = 9.992 – 1.500 = 8.492 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 22.668 kg
= 0.114 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 8.492 kg
= 0.0850 kg

Total extra water added = 0.114 + 0.0850 = 0.199 kg

Total water added to Concrete = 3.338 + 0.199 = 3.537 kg

Therefore,

Actual quantity of Coarse Aggregate required = 22.688 – 0.114 = 22.574 kg

Actual quantity of Fine Aggregate required = 8.492 – 0.0850 = 8.407 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 22.574 kg
= 4.515 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**C_{az}**	**Crumbs**
3.537 kg	6.953 kg	8.407 kg	18.059 kg	4.515 kg	1.500 kg

CONCRETE WITH 20% CRUMBS

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 20% compensation

$$= 4 \times (150)^3 \times 1.2 = 0.0162 \text{ m}^3$$

So,

Mass = 0.0162 × 24 × 1000/9.81 = 39.633 kg

Then,

Cement Required = 1/ (1+ 1.437 + 3.263) × 39.633 = 6.953 kg

Water Required = 0.480 / (1+ 1.437 + 3.263) × 39.633 = 3.338 kg

Fine Aggregate Required = 1.437 / (1+ 1.437 + 3.263) × 39.633 = 9.992 kg

Coarse Aggregate Required = 3.263 / (1+ 1.437 + 3.263) × 39.633 = 22.668 kg

Now,

Quantity of Crumbs added = 20% of 9.992 kg = 1.998 kg

So,

Quantity of Fine Aggregate required = 9.992 – 1.998 = 7.994 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 22.668 kg
= 0.114 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 7.994 kg
= 0.0799 kg

Total extra water added = 0.114 + 0.0799 = 0.194 kg

Total water added to Concrete = 3.338 + 0.194 = 3.532 kg

Therefore,

Actual quantity of Coarse Aggregate required = 22.688 – 0.114 = 22.574 kg

Actual quantity of Fine Aggregate required = 7.994 – 0.0799 = 7.914 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 22.574 kg
= 4.515 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**C_{az}**	**Crumbs**
3.532 kg	6.953 kg	7.914 kg	18.059 kg	4.515 kg	1.998 kg

APPENDIX – A3

Determination of Coarse Aggregate & Fine Aggregate

To find compressive strength of Concrete by Accelerated Curing Method, small cubes having 7.05 cm side and coarse aggregate of 10mm size is used. So, from **SP: 23-1982**, for 10mm size the percentage of voids is **3.0%.**

Take 3.0% Voids from Table 41 of SP: 23-1982, then

$$V = (W + C/S_c + 1/p.\ f_a/Sf_a) \times 1/1000$$

$$0.97 = (180.42 + 375.87/3.05 + 1/0.326 \times f_a/2.45) \times 1/1000$$

$$f_a = 532.174\ kg/m^3$$

Similarly,

$$V = (W + C/S_c + 1/1\text{-}p.\ C_{az}/S_{caz}) \times 1/1000$$

$$980 = (180.42 + 375.87/3.05 + 1/0.674 \times C_{az}/2.70)$$

$$C_{az} = 1212.532\ kg/m^3$$

So,

Mix Proportion is

Water	Cement	Fine Aggregate	Coarse Aggregate
180.42 kg	375.87 kg	532.174 kg	1212.532 kg
0.480	1.0	1.146	3.226

CONTROL MIX

Volume of Concrete required to cast 4 Cubes of 7.05 mm sides with 20% compensation

$$= 4 \times (0.0705)^3 \times 1.2 = 0.00168 \text{ m}^3$$

So,

Mass = 0.00168 × 24 × 1000/9.81 = 4.115 kg

Then,

Cement Required = 1/ (1+ 1.416 + 3.226) × 4.115 = 0.730 kg

Water Required = 0.480 / (1+ 1.416 + 3.226) × 4.115 = 0.350 kg

Fine Aggregate Required = 1.416 / (1+ 1.416 + 3.226) × 4.115 = 1.033 kg

Coarse Aggregate Required = 3.226 / (1+ 1.416 + 3.226) × 4.115 = 2.353 kg

Now,

Extra water added for absorption of Coarse Aggregate = 0.5% of 2.353 kg
= 0.0118 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 1.033 kg
= 0.0103 kg

Total extra water added = 0.0118 + 0.0103 = 0.0220 kg

Total water added to Concrete = 0.350 + 0.0220 = 0.372 kg

Therefore,

Actual quantity of Coarse Aggregate required = 2.353 – 0.0118 = 2.341 kg

Actual quantity of Fine Aggregate required = 1.033 – 0.0103 = 1.023 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**
0.372 kg	0.730 kg	1.023 kg	2.341 kg

CONCRETE WITH 5% CRUMBS

Volume of Concrete required to cast 4 Cubes of 7.05 mm sides with 20% compensation

$$= 4 \times (0.0705)^3 \times 1.2 = 0.00168 \text{ m}^3$$

So,

Mass = 0.00168 × 24 × 1000/9.81 = 4.115 kg

Then,

Cement Required = 1/ (1+ 1.416 + 3.226) × 4.115 = 0.730 kg

Water Required = 0.480 / (1+ 1.416 + 3.226) × 4.115 = 0.350 kg

Fine Aggregate Required = 1.416 / (1+ 1.416 + 3.226) × 4.115 = 1.033 kg

Coarse Aggregate Required = 3.226 / (1+ 1.416 + 3.226) × 4.115 = 2.353 kg

Now,

Quantity of Crumbs added = 5% of 1.033 kg = 0.052 kg

So,

Quantity of Fine Aggregate added = 1.033 – 0.052 = 0.982 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 2.353 kg
= 0.0118 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 0.982 kg
= 0.00982 kg

Total extra water added = 0.0118 + 0.00982 = 0.0216 kg

Total water added to Concrete = 0.350 + 0.0216 = 0.372 kg

Therefore,

Actual quantity of Coarse Aggregate required = 2.353 – 0.0118 = 2.341 kg

Actual quantity of Fine Aggregate required = 0.982 – 0.00982 = 0.972 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	Crumbs
0.372 kg	0.730 kg	0.972 kg	2.342 kg	0.0520 kg

CONCRETE WITH 10% CRUMBS

Volume of Concrete required to cast 4 Cubes of 7.05 mm sides with 20% compensation

$$= 4 \times (0.0705)^3 \times 1.2 = 0.00168 \text{ m}^3$$

So,

Mass = 0.00168 × 24 × 1000/9.81 = 4.115 kg

Then,

Cement Required = 1/ (1+ 1.416 + 3.226) × 4.115 = 0.730 kg

Water Required = 0.480 / (1+ 1.416 + 3.226) × 4.115 = 0.350 kg

Fine Aggregate Required = 1.416 / (1+ 1.416 + 3.226) × 4.115 = 1.033 kg

Coarse Aggregate Required = 3.226 / (1+ 1.416 + 3.226) × 4.115 = 2.353 kg

Now,

Quantity of Crumbs added = 10% of 1.033 kg = 0.104 kg

So,

Quantity of Fine Aggregate added = 1.033 – 0.104 = 0.929 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 2.353 kg
= 0.0118 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 0.982 kg
= 0.00929 kg

Total extra water added = 0.0118 + 0.00929 = 0.0211 kg

Total water added to Concrete = 0.350 + 0.0211 = 0.371 kg

Therefore,

Actual quantity of Coarse Aggregate required = 2.353 – 0.0118 = 2.342 kg

Actual quantity of Fine Aggregate required = 0.929 – 0.00929 = 0.920 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	Crumbs
0.372 kg	0.730 kg	0.920 kg	2.342 kg	0.104 kg

CONCRETE WITH 15% CRUMBS

Volume of Concrete required to cast 4 Cubes of 7.05 mm sides with 20% compensation

$$= 4 \times (0.0705)^3 \times 1.2 = 0.00168\ m^3$$

So,

Mass = 0.00168 × 24 × 1000/9.81 = 4.115 kg

Then,

Cement Required = 1/ (1+ 1.416 + 3.226) × 4.115 = 0.730 kg

Water Required = 0.480 / (1+ 1.416 + 3.226) × 4.115 = 0.350 kg

Fine Aggregate Required = 1.416 / (1+ 1.416 + 3.226) × 4.115 = 1.033 kg

Coarse Aggregate Required = 3.226 / (1+ 1.416 + 3.226) × 4.115 = 2.353 kg

Now,

Quantity of Crumbs added = 15% of 1.033 kg = 0.155 kg

So,

Quantity of Fine Aggregate added = 1.033 – 0.155 = 0.878 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 2.353 kg
= 0.0118 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 0.878 kg
= 0.00878 kg

Total extra water added = 0.0118 + 0.00878 = 0.021 kg

Total water added to Concrete = 0.350 + 0.021 = 0.371 kg

Therefore,

Actual quantity of Coarse Aggregate required = 2.353 – 0.0118 = 2.342 kg

Actual quantity of Fine Aggregate required = 0.878 – 0.00878 = 0.869 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**Crumbs**
0.372 kg	0.730 kg	0.869 kg	2.342 kg	0.155 kg

CONCRETE WITH 20% CRUMBS

Volume of Concrete required to cast 4 Cubes of 7.05 mm sides with 20% compensation

$$= 4 \times (0.0705)^3 \times 1.2 = 0.00168 \text{ m}^3$$

So,

Mass = 0.00168 × 24 × 1000/9.81 = 4.115 kg

Then,

Cement Required = 1/ (1+ 1.416 + 3.226) × 4.115 = 0.730 kg

Water Required = 0.480 / (1+ 1.416 + 3.226) × 4.115 = 0.350 kg

Fine Aggregate Required = 1.416 / (1+ 1.416 + 3.226) × 4.115 = 1.033 kg

Coarse Aggregate Required = 3.226 / (1+ 1.416 + 3.226) × 4.115 = 2.353 kg

Now,

Quantity of Crumbs added = 20% of 1.033 kg = 0.207 kg

So,

Quantity of Fine Aggregate added = 1.033 – 0.207 = 0.827 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 2.353 kg
= 0.0118 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 0.827 kg
= 0.00827 kg

Total extra water added = 0.0118 + 0.00827 = 0.0200 kg

Total water added to Concrete = 0.350 + 0.0200 = 0.370 kg

Therefore,

Actual quantity of Coarse Aggregate required = 2.353 – 0.0118 = 2.342 kg

Actual quantity of Fine Aggregate required = 0.827 – 0.00827 = 0.819 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	Crumbs
0.370 kg	0.730 kg	0.819 kg	2.342 kg	0.207 kg

APPENDIX – A4

CONTROL MIX

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 20% compensation

$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.2$
$= 0.0191\ m^3$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0191\ m^3 = 46.729$ kg

Then,

Cement Required = 1/ (1+1.437+3.263) × 46.729 = 8.198 kg

Water Required = 0.480/ (1+1.437+3.263) × 46.729 = 3.935 kg

Fine Aggregate Required = 1.437/ (1+1.437+3.263) × 46.729 = 11.780 kg

Coarse Aggregate Required = 3.263/ (1+1.437+3.263) × 46.729 = 26.749 kg

Now,

Extra Water added for the absorption of Fine Aggregate = 1.0% of 11.780 kg = 0.118 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 26.749kg
= 0.134 kg

Then,

Total Extra Water added = 0.118 + 0.134 = 0.252 kg

Also,

Total Water added to the Concrete = 3.935 + 0.252 = 4.187 kg

Actual Quantity of Fine aggregate added = 11.780 – 0.118 = 11.662 kg

Actual Quantity of Coarse aggregate added = 26.749 – 0.134 = 26.615 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 26.615 kg = 5.323 kg

So,

Coarse Aggregate added = 26.615 – 5.323 = 21.292 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**C_{az}**
4.187 kg	8.198 kg	11.662 kg	21.292 kg	5.323 kg

CONCRETE WITH 5% CRUMBS

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 20% compensation

$$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.2$$
$$= 0.0191\ m^3$$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0191\ m^3 = 46.729$ kg

Then,

Cement Required = 1/ (1+1.437+3.263) × 46.729 = 8.198 kg

Water Required = 0.480/ (1+1.437+3.263) × 46.729 = 3.935 kg

Fine Aggregate Required = 1.437/ (1+1.437+3.263) × 46.729 = 11.780 kg

Coarse Aggregate Required = 3.263/ (1+1.437+3.263) × 46.729 = 26.749 kg

Now,

Crumbs added = 5% of 11.780 kg = 0.589 kg

So,

Fine Aggregate added = 11.780 – 0.589 = 11.191 kg

Extra Water added for the absorption of Fine Aggregate = 1.0% of 11.191 kg = 0.112 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 26.749kg = 0.134 kg

Then,

Total Extra Water added = 0.112 + 0.134 = 0.246 kg

Also,

Total Water added to the Concrete = 3.935 + 0.246 = 4.181 kg

Actual Quantity of Fine aggregate added = 11.191 – 0.112 = 11.079 kg

Actual Quantity of Coarse aggregate added = 26.749 – 0.134 = 26.615 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 26.615 kg = 5.323 kg

So,

Coarse Aggregate added = 26.615 – 5.323 = 21.292 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
4.181 kg	8.198 kg	11.079 kg	21.292 kg	5.323 kg	0.589 kg

CONCRETE WITH 10% CRUMBS

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 20% compensation

$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.2$
$= 0.0191\ m^3$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0191\ m^3 = 46.729$ kg

Then,

Cement Required = 1/ (1+1.437+3.263) × 46.729 = 8.198 kg

Water Required = 0.480/ (1+1.437+3.263) × 46.729 = 3.935 kg

Fine Aggregate Required = 1.437/ (1+1.437+3.263) × 46.729 = 11.780 kg

Coarse Aggregate Required = 3.263/ (1+1.437+3.263) × 46.729 = 26.749 kg

Now,

Crumbs added = 10% of 11.780 kg = 1.178 kg

So,

Fine Aggregate added = 11.780 – 1.178 = 10.602 kg

Extra Water added for the absorption of Fine Aggregate = 1.0% of 10.602 kg = 0.106 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 26.749kg
= 0.134 kg

Then,

Total Extra Water added = 0.106 + 0.134 = 0.240 kg

Also,

Total Water added to the Concrete = 3.935 + 0.240 = 4.175 kg

Actual Quantity of Fine aggregate added = 10.602 – 0.106 = 10.496 kg

Actual Quantity of Coarse aggregate added = 26.749 – 0.134 = 26.615 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 26.615 kg = 5.323 kg

So,

Coarse Aggregate added = 26.615 – 5.323 = 21.292 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
4.175 kg	8.198 kg	10.496 kg	21.292 kg	5.323 kg	1.178 kg

CONCRETE WITH 15% CRUMBS

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 20% compensation

$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.2$
$= 0.0191\ m^3$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0191\ m^3 = 46.729$ kg

Then,

Cement Required = 1/ (1+1.437+3.263) × 46.729 = 8.198 kg

Water Required = 0.480/ (1+1.437+3.263) × 46.729 = 3.935 kg

Fine Aggregate Required = 1.437/ (1+1.437+3.263) × 46.729 = 11.780 kg

Coarse Aggregate Required = 3.263/ (1+1.437+3.263) × 46.729 = 26.749 kg

Now,

Crumbs added = 15% of 11.780 kg = 1.767 kg

So,

Fine Aggregate added = 11.780 – 1.767 = 10.013 kg

Extra Water added for the absorption of Fine Aggregate = 1.0% of 10.013 kg = 0.100 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 26.749kg
= 0.134 kg

Then,

Total Extra Water added = 0.100 + 0.134 = 0.234 kg

Also,

Total Water added to the Concrete = 3.935 + 0.234 = 4.169 kg

Actual Quantity of Fine aggregate added = 10.013 – 0.100 = 9.913 kg

Actual Quantity of Coarse aggregate added = 26.749 – 0.134 = 26.615 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 26.615 kg = 5.323 kg

So,

Coarse Aggregate added = 26.615 – 5.323 = 21.292 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
4.169 kg	8.198 kg	9.913 kg	21.292 kg	5.323 kg	1.767 kg

CONCRETE WITH 20% CRUMBS

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 20% compensation

$$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.2$$
$$= 0.0191\ m^3$$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0191\ m^3 = 46.729$ kg

Then,

Cement Required = 1/ (1+1.437+3.263) × 46.729 = 8.198 kg

Water Required = 0.480/ (1+1.437+3.263) × 46.729 = 3.935 kg

Fine Aggregate Required = 1.437/ (1+1.437+3.263) × 46.729 = 11.780 kg

Coarse Aggregate Required = 3.263/ (1+1.437+3.263) × 46.729 = 26.749 kg

Now,

Crumbs added = 20% of 11.780 kg = 2.356 kg

So,

Fine Aggregate added = 11.780 – 2.356 = 9.424 kg

Extra Water added for the absorption of Fine Aggregate = 1.0% of 9.424 kg = 0.0943 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 26.749kg = 0.134 kg

Then,

Total Extra Water added = 0.0943 + 0.134 = 0.228 kg

Also,

Total Water added to the Concrete = 3.935 + 0.228 = 4.163 kg

Actual Quantity of Fine aggregate added = 9.424 – 0.0943 = 9.329 kg

Actual Quantity of Coarse aggregate added = 26.749 – 0.134 = 26.615 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 26.615 kg = 5.323 kg

So,

Coarse Aggregate added = 26.615 – 5.323 = 21.292 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs
4.163 kg	8.198 kg	9.329 kg	21.292 kg	5.323 kg	2.356 kg

APPENDIX – A5

Determination of Coarse & Fine Aggregate with Shriram Cement

Take 2.0% Voids, then

$$V = (W + C/S_c + 1/p.\ f_a/Sf_a) \times 1/1000$$

$$0.98 = (\ 180.42 + 375.87/3.10 + 1/0.326 \times f_a/2.45\ ) \times 1/1000$$

$$f_a = 541.78\ kg/m^3$$

Similarly,

$$V = (W + C/S_c + 1/1\text{-}p.\ C_a/S_{ca}) \times 1/1000$$

$$980 = (180.42 + 375.87/3.10 + 1/0.674 \times C_a\ /2.69)$$

$$C_a = 1229.86\ kg/m^3$$

So,

Mix Proportion is

Water	Cement	Fine Aggregate	Coarse Aggregate
180.42 kg	375.87 kg	541.78 kg	1229.86 kg
0.480	1.0	1.442	3.272

CONTROL MIX

Volume of Concrete required to cast 4 Cubes of 150 mm sides with 10% compensation

$$= 4 \times (150)^3 \times 1.1 = 0.0149 \text{ m}^3$$

So,

Mass = 0.0149 × 24 × 1000/9.81 = 36.330 kg

Then,

Cement Required = 1/ (1+ 1.442 + 3.272) × 36.330 = 6.358 kg

Water Required = 0.480 / (1+ 1.442 + 3.272) × 36.330 = 3.052 kg

Fine Aggregate Required = 1.442 / (1+ 1.442 + 3.272) × 36.330 = 9.169 kg

Coarse Aggregate Required = 3.272 / (1+ 1.442 + 3.272) × 36.330 = 20.804 kg

Now,

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Extra water added for absorption of Fine Aggregate = 1.0% of 9.169 kg
= 0.0917 kg

Total extra water added = 0.104 + 0.0197 = 0.196 kg

Total water added to Concrete = 3.052 + 0.196 = 3.248 kg

Therefore,

Actual quantity of Coarse Aggregate required = 20.804 – 0.104 = 20.700 kg

Actual quantity of Fine Aggregate required = 9.169 – 0.0197 = 9.077 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.14 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	**C_{az}**
3.248 kg	6.358 kg	9.077 kg	16.560 kg	4.140 kg

CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.169 kg
= 0.0917 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0917 + 0.104 = 0.196 kg

Total quantity of Water added = 3.052 + 0.196 = 3.248 kg

So,

Actual quantity of Fine Aggregate added = 9.169 – 0.0917 = 9.077 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 0.5% of 6.358 = 0.0318 kg

So,

Net quantity of Cement added = 6.358 – 0.0318 = 6.326 kg

Net quantity of Water added = 3.248 – 0.0318 = 3.216 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
3.216 kg	6.326 kg	9.077 kg	16.560 kg	4.140 kg	0.0318 kg

CONCRETE WITHOUT CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.169 kg
= 0.0917 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0917 + 0.104 = 0.196 kg

Total quantity of Water added = 3.052 + 0.196 = 3.248 kg

So,

Actual quantity of Fine Aggregate added = 9.169 – 0.0917 = 9.077 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.0% of 6.358 = 0.0636 kg

So,

Net quantity of Cement added = 6.358 – 0.0636 = 6.295 kg

Net quantity of Water added = 3.248 – 0.0636 = 3.185 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
3.185 kg	6.295 kg	9.077 kg	16.560 kg	4.140 kg	0.0636 kg

—

CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.169 kg
= 0.0917 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0917 + 0.104 = 0.196 kg

Total quantity of Water added = 3.052 + 0.196 = 3.248 kg

So,

Actual quantity of Fine Aggregate added = 9.169 – 0.0917 = 9.077 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.5% of 6.358 = 0.0954 kg

So,

Net quantity of Cement added = 6.358 – 0.0954 = 6.263 kg

Net quantity of Water added = 3.248 – 0.0954 = 3.153 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
3.153 kg	6.263 kg	9.077 kg	16.560 kg	4.140 kg	0.0954 kg

CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 5.0% of 9.169 kg = 0.458 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.458 = 8.710 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.710 kg
= 0.0871 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0871 + 0.104 = 0.191 kg

Total quantity of Water added = 3.052 + 0.191 = 3.243 kg

So,

Actual quantity of Fine Aggregate added = 8.710 – 0.0871 = 8.623 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 0.5% of 6.358 = 0.0318 kg

So,

Net quantity of Cement added = 6.358 – 0.0318 = 6.326 kg

Net quantity of Water added = 3.243 – 0.0318 = 3.211 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.211 kg	6.326 kg	8.623 kg	16.560 kg	4.140 kg	0.458 kg	0.0318 kg

CONCRETE WITH 5% CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 5.0% of 9.169 kg = 0.458 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.458 = 8.710 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.710 kg = 0.0871 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg = 0.104 kg

Total Extra Water added = 0.0871 + 0.104 = 0.191 kg

Total quantity of Water added = 3.052 + 0.191 = 3.243 kg

So,

Actual quantity of Fine Aggregate added = 8.710 – 0.0871 = 8.623 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg = 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.0% of 6.358 = 0.0636 kg

So,

Net quantity of Cement added = 6.358 – 0.0636 = 6.295 kg

Net quantity of Water added = 3.243 – 0.0636 = 3.180 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.180 kg	6.295 kg	8.623 kg	16.560 kg	4.140 kg	0.458 kg	0.0636 kg

CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 5.0% of 9.169 kg = 0.458 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.458 = 8.710 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.710 kg = 0.0871 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg = 0.104 kg

Total Extra Water added = 0.0871 + 0.104 = 0.191 kg

Total quantity of Water added = 3.052 + 0.191 = 3.243 kg

So,

Actual quantity of Fine Aggregate added = 8.710 – 0.0871 = 8.623 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg = 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.5% of 6.358 = 0.0954 kg

So,

Net quantity of Cement added = 6.358 – 0.0954 = 6.263 kg

Net quantity of Water added = 3.243 – 0.0954 = 3.148 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.148 kg	6.263 kg	8.623 kg	16.560 kg	4.140 kg	0.458 kg	0.0954 kg

CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 10% of 9.169 kg = 0.917 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.917 = 8.252 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.252 kg
= 0.0825 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0825 + 0.104 = 0.186 kg

Total quantity of Water added = 3.052 + 0.186 = 3.239 kg

So,

Actual quantity of Fine Aggregate added = 8.252 – 0.0825 = 8.170 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 0.5% of 6.358 = 0.0318 kg

So,

Net quantity of Cement added = 6.358 – 0.0318 = 6.326 kg

Net quantity of Water added = 3.239 – 0.0318 = 3.207 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.207 kg	6.326 kg	8.170 kg	16.560 kg	4.140 kg	0.917 kg	0.0318 kg

CONCRETE WITH 10% CRUMBS & 1.0 % ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 10% of 9.169 kg = 0.917 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.917 = 8.252 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.252 kg
= 0.0825 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0825 + 0.104 = 0.186 kg

Total quantity of Water added = 3.052 + 0.186 = 3.239 kg

So,

Actual quantity of Fine Aggregate added = 8.252 – 0.0825 = 8.170 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.0 % of 6.358 = 0.0636 kg

So,

Net quantity of Cement added = 6.358 – 0.0636 = 6.294 kg

Net quantity of Water added = 3.239 – 0.0636 = 3.176 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.176 kg	6.294 kg	8.170 kg	16.560 kg	4.140 kg	0.917 kg	0.0636 kg

CONCRETE WITH 10% CRUMBS & 1.5 % ADMIXTURE

Quantity of Fine Aggregate Required = 9.169 kg

Quantity of Crumbs added = 10% of 9.169 kg = 0.917 kg

So,

Net quantity of Fine Aggregate added = 9.169 - 0.917 = 8.252 kg

Quantity of Coarse Aggregate Required = 20.804 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 8.252 kg
= 0.0825 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.804 kg
= 0.104 kg

Total Extra Water added = 0.0825 + 0.104 = 0.186 kg

Total quantity of Water added = 3.052 + 0.186 = 3.239 kg

So,

Actual quantity of Fine Aggregate added = 8.252 – 0.0825 = 8.170 kg

Actual quantity of Coarse Aggregate added = 20.804 – 0.104 = 20.700 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 20.700 kg
= 4.140 kg

Therefore,

Coarse aggregate added = 20.700 – 4.140 = 16.560 kg

Now,

Quantity of Admixture added = 1.5 % of 6.358 = 0.0954 kg

So,

Net quantity of Cement added = 6.358 – 0.0954 = 6.263 kg

Net quantity of Water added = 3.239 – 0.0954 = 3.144 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.144 kg	6.263 kg	8.170 kg	16.560 kg	4.140 kg	0.917 kg	0.0954 kg

APPENDIX – A6

CONTROL MIX

Volume of Concrete required for Casting 3 Cylinders of 150mm Diameter & 300mm Height with 10% compensation

$$= 3\ [\pi\ (0.15)^2/4 \times 0.30] \times 1.1$$
$$= 0.0175\ m^3$$

Therefore,

Mass $= [24 \times 1000/9.81] \times 0.0175\ m^3 = 42.800$ kg

Then,

Cement Required = 1/ (1+1.442+3.272) × 42.800 = 7.490 kg

Water Required = 0.480/ (1+1.442+3.272) × 42.800 = 3.595 kg

Fine Aggregate Required = 1.442/ (1+1.442+3.272) × 42.800 = 10.801 kg

Coarse Aggregate Required = 3.272/ (1+1.442+3.272) × 42.800 = 24.509 kg

Extra Water added for the absorption of Fine Aggregate = 1.0% of 10.801 kg = 0.108 kg

Extra Water added for the absorption of Coarse Aggregate = 0.5% of 24.509kg
= 0.123 kg

Then,

Total Extra Water added = 0.108 + 0.123 = 0.231 kg

Also,

Total Water added to the Concrete = 3.595 + 0.231 = 3.826 kg

Actual Quantity of Fine aggregate added = 10.801 – 0.108 = 10.693 kg

Actual Quantity of Coarse aggregate added = 24.509 – 0.123 = 24.386 kg

Coarse aggregate of 10mm size required (C_{az}) = 20% of 24.386 kg = 4.877 kg

So,

Coarse Aggregate added = 24.386 – 4.877 = 19.509 kg

Mix Proportion

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	C_{az}
3.826 kg	7.490 kg	10.693 kg	19.509 kg	4.877 kg

CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 5.0% of 10.801 kg = 0.540 kg

So,

Net quantity of Fine Aggregate added = 10.801 - 0.540 = 10.261 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.261 kg = 0.103 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg = 0.123 kg

Total Extra Water added = 0.103 + 0.123 = 0.226 kg

Total quantity of Water added = 3.595 + 0.226 = 3.820 kg

So,

Actual quantity of Fine Aggregate added = 10.261 – 0.103 = 10.158 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg = 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 0.5% of 7.490 = 0.0375 kg

So,

Net quantity of Cement added = 7.490 – 0.0375 = 7.453 kg

Net quantity of Water added = 3.820 – 0.0375 = 3.783 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.783 kg	7.453 kg	10.158 kg	19.509 kg	4.877 kg	0.540 kg	0.0375 kg

CONCRETE WITH 5% CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 5.0% of 10.801 kg = 0.540 kg

So,

Net quantity of Fine Aggregate added = 10.801 - 0.540 = 10.261 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.261 kg
= 0.103 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.103 + 0.123 = 0.226 kg

Total quantity of Water added = 3.595 + 0.226 = 3.820 kg

So,

Actual quantity of Fine Aggregate added = 10.261 – 0.103 = 10.158 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.0% of 7.490 = 0.0749 kg

So,

Net quantity of Cement added = 7.490 – 0.0749 = 7.415 kg

Net quantity of Water added = 3.820 – 0.0749 = 3.745 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.745 kg	7.415 kg	10.158 kg	19.509 kg	4.877 kg	0.540 kg	0.0749 kg

CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 5.0% of 10.801 kg = 0.540 kg

So,

Net quantity of Fine Aggregate added = 10.801 - 0.540 = 10.261 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.261 kg
= 0.103 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.103 + 0.123 = 0.226 kg

Total quantity of Water added = 3.595 + 0.226 = 3.820 kg

So,

Actual quantity of Fine Aggregate added = 10.261 – 0.103 = 10.158 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.5% of 7.490 = 0.113 kg

So,

Net quantity of Cement added = 7.490 – 0.113 = 7.378 kg

Net quantity of Water added = 3.820 – 0.113 = 3.707 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.707 kg	7.378 kg	10.158 kg	19.509 kg	4.877 kg	0.540 kg	0.113 kg

CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 10.0% of 10.801 kg = 1.080 kg

So,

Net quantity of Fine Aggregate added = 10.801 – 1.080 = 9.720 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.720 kg
= 0.0972 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.0972 + 0.123 = 0.219 kg

Total quantity of Water added = 3.595 + 0.219 = 3.814 kg

So,

Actual quantity of Fine Aggregate added = 9.720 – 0.0972 = 9.623 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 0.5% of 7.490 = 0.0375 kg

So,

Net quantity of Cement added = 7.490 – 0.0375 = 7.453 kg

Net quantity of Water added = 3.814 – 0.0375 = 3.777 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.777 kg	7.453 kg	9.623 kg	19.509 kg	4.877 kg	1.080 kg	0.0375 kg

CONCRETE WITH 10% CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 10.0% of 10.801 kg = 1.080 kg

So,

Net quantity of Fine Aggregate added = 10.801 – 1.080 = 9.720 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.720 kg
= 0.0972 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.0972 + 0.123 = 0.219 kg

Total quantity of Water added = 3.595 + 0.219 = 3.814 kg

So,

Actual quantity of Fine Aggregate added = 9.720 – 0.0972 = 9.623 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.0% of 7.490 = 0.0749 kg

So,

Net quantity of Cement added = 7.490 – 0.0749 = 7.415 kg

Net quantity of Water added = 3.814 – 0.0749 = 3.739 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.739 kg	7.415 kg	9.623 kg	19.509 kg	4.877 kg	1.080 kg	0.0749 kg

CONCRETE WITH 10% CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Quantity of Crumbs added = 10.0% of 10.801 kg = 1.080 kg

So,

Net quantity of Fine Aggregate added = 10.801 – 1.080 = 9.720 kg

Quantity of Coarse Aggregate Required = 20.509 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 9.720 kg
= 0.0972 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.0972 + 0.123 = 0.219 kg

Total quantity of Water added = 3.595 + 0.219 = 3.814 kg

So,

Actual quantity of Fine Aggregate added = 9.720 – 0.0972 = 9.623 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.5% of 7.490 = 0.113 kg

So,

Net quantity of Cement added = 7.490 – 0.113 = 7.378 kg

Net quantity of Water added = 3.814 – 0.113 = 3.702 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
3.702 kg	7.378 kg	9.623 kg	19.509 kg	4.877 kg	1.080 kg	0.113 kg

CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.801 kg
= 0.108 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.108 + 0.123 = 0.231 kg

Total quantity of Water added = 3.595 + 0.231 = 3.826 kg

So,

Actual quantity of Fine Aggregate added = 10.801 – 0.108 = 10.693 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 0.5% of 7.490 = 0.0375 kg

So,

Net quantity of Cement added = 7.490 – 0.0375 = 7.453 kg

Net quantity of Water added = 3.814 – 0.0375 = 3.777 kg

Mix Proportion:-

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**	C_{az}	**Admixture**
3.777 kg	7.453 kg	10.693 kg	19.509 kg	4.877 kg	0.0375 kg

CONCRETE WITHOUT CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.801 kg
= 0.108 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.108 + 0.123 = 0.231 kg

Total quantity of Water added = 3.595 + 0.231 = 3.826 kg

So,

Actual quantity of Fine Aggregate added = 10.801 – 0.108 = 10.693 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.0% of 7.490 = 0.0749 kg

So,

Net quantity of Cement added = 7.490 – 0.0749 = 7.415 kg

Net quantity of Water added = 3.814 – 0.0749 = 3.739 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
3.739 kg	7.415 kg	10.693 kg	19.509 kg	4.877 kg	0.0749 kg

CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 10.801 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 10.801 kg
= 0.108 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 20.509 kg
= 0.123 kg

Total Extra Water added = 0.108 + 0.123 = 0.231 kg

Total quantity of Water added = 3.595 + 0.231 = 3.826 kg

So,

Actual quantity of Fine Aggregate added = 10.801 – 0.108 = 10.693 kg

Actual quantity of Coarse Aggregate added = 20.509 – 0.123 = 24.386 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 24.386 kg
= 4.877 kg

Therefore,

Coarse aggregate added = 20.386 – 4.877 = 19.509 kg

Now,

Quantity of Admixture added = 1.5% of 7.490 = 0.113 kg

So,

Net quantity of Cement added = 7.490 – 0.113 = 7.378 kg

Net quantity of Water added = 3.814 – 0.113 = 3.702 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
3.702 kg	7.378 kg	10.693 kg	19.509 kg	4.877 kg	0.113 kg

APPENDIX – A7

CONTROL MIX

Volume of Concrete required to cast 4 Beam Specimen of size 50cm×10cm×10cm with 10% compensation.

$= 4×0.00530×1.1 = 0.0234$ m3

So,

Mass = 0.0234× 24×1000/9.81 = 57.079 kg

Then,

Cement Required= 1/ (1+1.442+3.272) × 57.079 = 9.989 kg

Water Required = 0.480/ (1+1.442+3.272) × 57.079 = 4.795 kg

Fine Aggregate Required = 1.442/ (1+1.442+3.272) × 57.079 = 14.405 kg

Coarse Aggregate Required = 3.272/(1+1.442+3.272) × 57.079 = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 14.405 = 0.144 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685=0.164 kg

So,

Total extra water added in Concrete = 0.308 kg

Actual quantity of water added = 4.795+0.038 = 5.103 kg

Therefore,

Actual quantity of Fine Aggregate added = 14.405-0.144 = 14.261 kg

Actual quantity of Coarse Aggregate added = 32.685-0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

So,

Coarse Aggregate added = 32.521-6.504 = 26.017 kg

Mix Proportion

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}
5.103 kg	9.989 kg	14.261 kg	26.017 kg	6.504 kg

CONCRETE WITHOUT CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 14.405 kg
= 0.144 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.144 + 0.164 = 0.308 kg

Total quantity of Water added = 4.795 + 0.308 = 5.103 kg

So,

Actual quantity of Fine Aggregate added = 14.405 – 0.144 = 14.261 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 0.5% of 9.989 = 0.0500 kg

So,

Net quantity of Cement added = 9.989 – 0.0500 = 9.939 kg

Net quantity of Water added = 5.103 – 0.0500 = 5.053 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
5.053 kg	9.939 kg	14.261 kg	26.017 kg	6.504 kg	0.0500 kg

CONCRETE WITHOUT CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 14.405 kg
= 0.144 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.144 + 0.164 = 0.308 kg

Total quantity of Water added = 4.795 + 0.308 = 5.103 kg

So,

Actual quantity of Fine Aggregate added = 14.405 – 0.144 = 14.261 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.0% of 9.989 = 0.0999 kg

So,

Net quantity of Cement added = 9.989 – 0.0999 = 9.889 kg

Net quantity of Water added = 5.103 – 0.0999 = 5.003 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
5.003 kg	9.889 kg	14.261 kg	26.017 kg	6.504 kg	0.0999 kg

CONCRETE WITHOUT CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 14.405 kg
= 0.144 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.144 + 0.164 = 0.308 kg

Total quantity of Water added = 4.795 + 0.308 = 5.103 kg

So,

Actual quantity of Fine Aggregate added = 14.405 – 0.144 = 14.261 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.5% of 9.989 = 0.150 kg

So,

Net quantity of Cement added = 9.989 – 0.150 = 9.839 kg

Net quantity of Water added = 5.103 – 0.150 = 4.953 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Admixture
4.953 kg	9.839 kg	14.261 kg	26.017 kg	6.504 kg	0.150 kg

CONCRETE WITH 5% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 5.0% of 14.405 kg = 0.720 kg

So,

Net quantity of Fine Aggregate added = 14.405-0.720 = 13.685 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 13.685 kg
= 0.137 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.137 + 0.164 = 0.300 kg

Total quantity of Water added = 4.795 + 0.300 = 5.096 kg

So,

Actual quantity of Fine Aggregate added = 13.685 – 0.137 = 13.548 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 0.5% of 9.989 = 0.0500 kg

So,

Net quantity of Cement added = 9.989 – 0.0500 = 9.939 kg

Net quantity of Water added = 5.096 – 0.0500 = 5.046 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
5.046 kg	9.939 kg	13.548 kg	26.017 kg	6.504 kg	0.720 kg	0.0500 kg

CONCRETE WITH 5% CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 5.0% of 14.405 kg = 0.720 kg

So,

Net quantity of Fine Aggregate added = 14.405-0.720 = 13.685 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 13.685 kg = 0.137 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg = 0.164 kg

Total Extra Water added = 0.137 + 0.164 = 0.300 kg

Total quantity of Water added = 4.795 + 0.300 = 5.096 kg

So,

Actual quantity of Fine Aggregate added = 13.685 – 0.137 = 13.548 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg = 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.0% of 9.989 = 0.0999 kg

So,

Net quantity of Cement added = 9.989 – 0.0999 = 9.889 kg

Net quantity of Water added = 5.096 – 0.0999 = 4.996 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
4.996 kg	9.889 kg	13.548 kg	26.017 kg	6.504 kg	0.720 kg	0.0999 kg

CONCRETE WITH 5% CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 5.0% of 14.405 kg = 0.720 kg

So,

Net quantity of Fine Aggregate added = 14.405-0.720 = 13.685 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 13.685 kg = 0.137 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg = 0.164 kg

Total Extra Water added = 0.137 + 0.164 = 0.300 kg

Total quantity of Water added = 4.795 + 0.300 = 5.096 kg

So,

Actual quantity of Fine Aggregate added = 13.685 – 0.137 = 13.548 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg = 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.5% of 9.989 = 0.150 kg

So,

Net quantity of Cement added = 9.989 – 0.150 = 9.840 kg

Net quantity of Water added = 5.096 – 0.150 = 4.946 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
4.946 kg	9.840 kg	13.548 kg	26.017 kg	6.504 kg	0.720 kg	0.150 kg

CONCRETE WITH 10% CRUMBS & 0.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 10.0% of 14.405 kg = 1.440 kg

So,

Net quantity of Fine Aggregate added = 14.405-1.440 = 12.965 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 12.965 kg
= 0.129 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.129 + 0.164 = 0.293 kg

Total quantity of Water added = 4.795 + 0.293 = 5.087 kg

So,

Actual quantity of Fine Aggregate added = 12.965 – 0.129 = 12.836 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 0.5% of 9.989 = 0.0500 kg

So,

Net quantity of Cement added = 9.989 – 0.0500 = 9.939 kg

Net quantity of Water added = 5.096 – 0.0500 = 5.046 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
5.037 kg	9.939 kg	12.836 kg	26.017 kg	6.504 kg	1.440 kg	0.0500 kg

CONCRETE WITH 10% CRUMBS & 1.0% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 10.0% of 14.405 kg = 1.440 kg

So,

Net quantity of Fine Aggregate added = 14.405-1.440 = 12.965 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 12.965 kg
= 0.129 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.129 + 0.164 = 0.293 kg

Total quantity of Water added = 4.795 + 0.293 = 5.087 kg

So,

Actual quantity of Fine Aggregate added = 12.965 – 0.129 = 12.836 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.0% of 9.989 = 0.0999 kg

So,

Net quantity of Cement added = 9.989 – 0.0999 = 9.889 kg

Net quantity of Water added = 5.087 – 0.0999 = 4.987 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
4.987 kg	9.889 kg	12.836 kg	26.017 kg	6.504 kg	1.440 kg	0.0999 kg

CONCRETE WITH 10% CRUMBS & 1.5% ADMIXTURE

Quantity of Fine Aggregate Required = 14.405 kg

Quantity of Crumbs added = 10.0% of 14.405 kg = 1.440 kg

So,

Net quantity of Fine Aggregate added = 14.405-1.440 = 12.965 kg

Quantity of Coarse Aggregate Required = 32.685 kg

Now,

Extra water added for absorption of Fine Aggregate = 1.0% of 12.965 kg
= 0.129 kg

Extra water added for absorption of Coarse Aggregate = 0.5% of 32.685 kg
= 0.164 kg

Total Extra Water added = 0.129 + 0.164 = 0.293 kg

Total quantity of Water added = 4.795 + 0.293 = 5.087 kg

So,

Actual quantity of Fine Aggregate added = 12.965 – 0.129 = 12.836 kg

Actual quantity of Coarse Aggregate added = 32.685 – 0.164 = 32.521 kg

Quantity of Coarse Aggregate of 10mm size added (C_{az}) =20% of 32.521 kg
= 6.504 kg

Therefore,

Coarse aggregate added = 32.521 – 6.504 = 26.017 kg

Now,

Quantity of Admixture added = 1.5% of 9.989 = 0.150 kg

So,

Net quantity of Cement added = 9.989 – 0.150 = 9.839 kg

Net quantity of Water added = 5.096 – 0.150 = 4.946 kg

Mix Proportion:-

Water	Cement	Fine Aggregate	Coarse Aggregate	C_{az}	Crumbs	Admixture
4.946 kg	9.839 kg	12.836 kg	26.017 kg	6.504 kg	1.440 kg	0.150 kg